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THE GYPSY MOTH & THE BROWN-TAIL MOTH
A History of the Work for Prevention of
Spread and Extermination of These Insects
in North America
by
A. F. ~~Burgs~~ BURGESS

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THE GYPSY MOTH AND THE BROWNTAIL MOTH

A History of the Work for Prevention of Spread and Extermination of these Insects in North America

by

A. F. Burgess

Content pages prepared March 1984

by Paul W. Schaefer
USDA, BIRL, Newark, DE

Burgess, A. F. 1944 (Manuscript, apparently unpublished)
The gypsy moth and the brown-tail moth. A history of the work for prevention of spread and extermination of these insects in North America.

Copy on file at the USDA, Bioenviromental Bee Lab., BARC, Beltsville, MD
Manuscript contains 545 double spaced pages and 81 plates, most photographs.
February 1984, Paul W. Schaefer

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A. F. Burgess

Attention is called to the frontispiece (Plate I) of this report which contains the pictures of the men responsible for the policies of the gypsy moth work in the early days. They were "The Pioneers".

William R. Sessions, Secretary of the Massachusetts Board of Agriculture.

Charles H. Fernald, noted entomologist, teacher and research professor at the Massachusetts Agricultural College as well as entomologist to the State Board of Agriculture.

Edward H. Forbush, director of the field work.

Archie H. Kirkland who as a result of entomological training and experience became superintendent of the Massachusetts work.

Dr. L. O. Howard, Chief of the United States Bureau of Entomology, the most outstanding entomologist of his time in the United States and widely known and respected internationally. There is hardly a country in the world where his helpful influence has not reached and his personal and, in most cases, intimate acquaintance with official entomologists as well as other men of science made an indelible imprint.

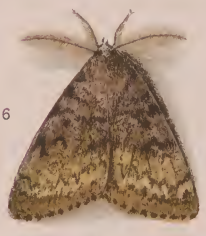
All of these men with the exception of Dr. Howard have passed away but he at the age of 86 still retains his interest and devotion to entomology in all its aspects. I have known him at least since 1897 and served as one of his assistants on the gypsy moth work for

THE GYPSY MOTH

ITS DIFFERENT STAGES FROM EGG CLUSTER TO THE ADULT MOTH
NATURAL SIZE AND COLOR

5
Male Moth

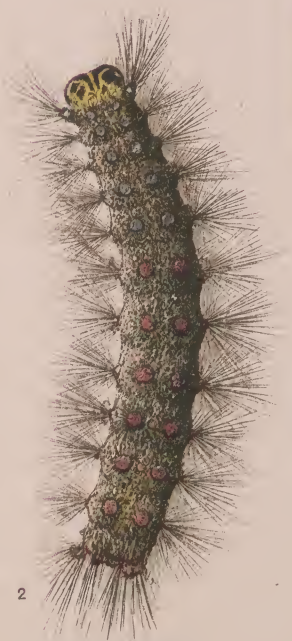
7
Female Moth



6
Male Moth at rest

8
Female Moth
laying eggs

3
Female Pupa



2
Full Grown Caterpillar

4
Male Pupa

1
Egg Mass

SEE OTHER SIDE

SEE OTHER SIDE

COCKAYNE, BOSTON, LITH.

PUBLISHED BY
CONSERVATION DEPARTMENT, ALBANY, N. Y.

KRIEGER, DEL

GIPSY MOTH—KEEP IT OUT.

The Gipsy Moth is a serious enemy of ornamental, shade, fruit and forest trees.

Control work is now costing the New England property owners about one million dollars annually. It threatens New York State along most of the eastern boundary.

Exclusion is cheaper than control over extended areas, hence the Barrier Zone.

A barrier zone means the application of exterminative measures to as much as may be necessary of a strip some 25 miles wide and reaching across the front of the infested area in western New England and eastern New York, extending from the Canadian border to Long Island Sound. The topographic conditions over the entire area seem most favorable toward the project.

The exclusion of this pest depends largely upon team work. May the State of New York have your cooperation in this great undertaking?

The Gipsy Moth invasion of the Hudson Valley is threatened. The caterpillars are easily carried in early summer in camping outfits or on automobiles. Avoid camping or parking near infested areas. Travelers from New England are requested to carefully examine their equipment and be sure that it is free from this insect. Young trees and evergreens may bear unseen egg masses or caterpillars. It is a violation of law to transport trees and shrubs from New England without a federal inspection certificate. Kindly comply with regulations. Help keep the Gipsy Moth out of New York State.

On the opposite side there are illustrations of all stages of the Gipsy Moth. The egg mass (1), which should not be removed on account of the danger of breakage, occurs on the trunks of trees, on stone walls and fences from August to May. In May, and frequently in an early season, in April, the tiny caterpillars hatch from the eggs and feed on leaves of apple, oak, birch, maple, elms and of almost all deciduous trees until full grown in July (2). The full grown caterpillars seek some spot in which to change to pupae (3) and (4), preferably under loose bark, burlap or other shelter. In early August, or from about seven to ten days after entering the pupal stage, the moths emerge. The male moth (5 and 6) flies, but the female moth (7) does not move far from the spot where she issues from the pupa. She lays her eggs (8) near the spot where she emerged and dies soon after.

Any insects thought to be the Gipsy Moths will be promptly identified if sent to the Conservation Department, Albany, N. Y. Do not send in egg masses, since there is danger of scattering the pest if the mass is removed.

The Gipsy Moth must be very closely controlled in the Barrier Zone and for this purpose the Conservation Department has been given wide discretionary powers. Wild and worthless apple trees should be destroyed. The oaks, birches and poplars, upon which the Gipsy Moth thrives most, should be first selected when providing the fuel supply. Property owners can help some with this.

We advocate replanting, where trees are removed, with trees upon which the insect lives with difficulty, such as pure stands of pine and other evergreens, or with other productive trees.

Systematic and repeated scoutings throughout the Barrier Zone and its vicinity are necessary. This work is so planned as to result in the destruction of all sparse infestations and the speedy delimitations of more serious conditions when found, and should be supported accordingly.

The inconveniences which may come to residents of the Barrier Zone are much less than those resulting from a serious infestation of the Gipsy Moth. Hence, the State should have the cooperatian of all in this undertaking.

CONSERVATION DEPARTMENT,

ALBANY, N. Y.

8-25-36-8752

more than 20 years until his retirement as Chief of the Bureau in 1927, with his successors in the Bureau from that time until November 1, 1943 as well as with his associates on the Massachusetts work prior to 1900.

The preparation of the history which follows affords me an opportunity to express my gratitude to and respect for these men and to hope that it will make possible a more complete realization of their accomplishments and the protection that the United States has received as a result of their tireless efforts.

A. F. Burgess

Greenfield, Massachusetts

April 19, 1944

Preface

In a letter to me dated August 6, 1942 from Dr. P. N. Annand, Chief of the Bureau, I was requested to meet him at the Bureau office in Washington on August 11 to discuss the future of the gypsy moth program. At this meeting he decided to put the gypsy moth project in charge of Mr. R. A. Sheals and have me devote the remaining time prior to my retirement on October 31, 1943 in preparing a history of the gypsy moth work. This arrangement went into effect August 16, 1942.

Arrangements were made for necessary space and assistance at the Greenfield office and cooperation with the different States relative to furnishing data was secured. The time available proved to be inadequate on account of the volume of material which it was necessary to examine and evaluate and it was not until April 1944 that the report was completed.

This report covers work on the gypsy moth from 1890 to the present time and on the brown-tail moth from the time it was found in Massachusetts in 1897. In view of the fact that these two imported European pests were found in the same general region in eastern Massachusetts and now occur most abundantly in these regions research and control work were combined as far as possible in the attack on both species.

It has seemed best to prepare the report on a chronological basis and it is divided into parts which cover the work during periods which seem most closely related without interrupting the general chronological

arrangement. Reference is made in the text to various publications which cover special subjects in greater detail. This makes it convenient for the reader who may be interested in some special phases of the work to secure the information desired without extensive reading of other details.

Free use has been made of information published by the States together with pertinent illustrations and sincere appreciation is expressed for information and help to those agencies as well as various activities of the United States Department of Agriculture and many other interested sources.

The preparation of the report has required consultation and digesting of hundreds of reports, bulletins, newspaper and other articles which have been published through the years, a single report requiring the study and evaluation of over 1,500 pages, in addition to official records and correspondence in the field offices.

My thanks are due to Mr. Sheals who has extended every courtesy in providing personnel and other assistance, to Mr. H. B. Dalton for many suggestions for the presentation of fiscal and financial development in the administration of the work, to Mr. H. L. Blaisdell for the preparation of the sections on scouting and spraying methods and other details concerning the field work, to Mr. C. E. Hood and Mr. W. C. Kurtz for the preparation of photographs and maps, to Mr. L. L. Pierce and Miss M. A. Smith who have toiled ceaselessly on many of the details, to

the members of the office and shop organizations, and to the field employees who have most obligingly placed at my disposal information on many varied aspects of this work. Preparation of this report would have been well-nigh impossible without this willing help.

For the convenience of the reader there follows a brief description of the gypsy moth with information concerning its range in foreign countries and facts concerning its life history and habits. There is also included later in the report similar information concerning the brown-tail moth (Plate XI) which was introduced some years later in the same territory where the gypsy moth was first found in Massachusetts.

The Gypsy Moth

This insect was first described by Linnaeus in 1758, although it had become an object of notice some years earlier by many biologists throughout Europe. It was popularly known by many names, descriptive of its physical characteristics or habits, but apparently was first called the "gypsy moth" by Wilkes in 1741. As a result of a study of the literature concerning this moth Prof. C. H. Fernald compiled a bibliography of 397 references including those published by Geodart in his "Historice des Insectes", vol. 1, pp. 118, 142, published in 1662 and other papers published in Europe concerning studies and reports of his contemporaries.

The information thus available indicated the native distribution of this pest extended through western, middle and southern Europe,

western Asia and Northern Africa, reaching from Stockholm to Algiers and from England to the Altai Mountains and the Caspian Sea. It extended, also, into eastern Asia, including eastern Siberia and Japan and down to the tropics in Ceylon.

In the old world of Europe records of widespread destruction were plentiful and methods of combatting its ravages were fully described. These methods aimed largely to control rather than toward prevention of spread or extermination and relied greatly on natural factors such as predators and parasites. During periods of heavy infestation efforts at control were directed against the egg clusters which were scraped from the trees and burned or covered with raupenleim or other materials to prevent hatching and against the caterpillars by the use of so-called "catch-bands" placed around the trees, which consisted of cloth treated with deterring material such as tar, raupenleim, ink, petroleum products or other viscid substances.

Life History of the Gypsy Moth
(Plate IX)

The Eggs

The gypsy moth eggs are laid in oval or rounded clusters in the early summer, soon after emergence of the moths and are neatly covered with yellowish buff-colored hairs from the body of the female. Each cluster generally contains from 400 to 500 eggs,although a single cluster has been recorded containing 1,400 eggs. The size of the egg clusters depends largely upon the size of the female moth. The eggs are salmon colored when first laid but soon darken owing to the development of the embryo and the covering hairs fade after long exposure. The eggs are laid usually in more or less sheltered places on the tree trunks or under sides of the branches, in tree cavities and sometimes under loose bark. In very heavy infestations clusters may be deposited in many places such as on the forest litter near trees, on stones, ledges, rubbish, sometimes on the under sides of foliage and on the foundations or sides of buildings.

The Larvae

The majority of the eggs in each cluster hatch during warm days, generally early in May in New England, but this begins some years in late April and hatching occasionally continues to June 1, depending on seasonal conditions. Hatching begins during the warm part of the day and may continue for several days. The first stage larvae are about fourteen hundredths of an inch long, a pale brownish yellow in color, and covered with two kinds of hairs, one set being pale brown each with an inflated globule at the basal third, the other is unusually

long with rows of minute barbs the entire length.

Larvae that become male moths molt five times and those becomming females molt six times, the period between molts varying from five to eleven days depending upon food and weather conditions. The full-grown larva is from 1½ to 2½ inches long; the head has yellow markings, the body is dusky or sooty colored, hairy, and on the dorsum is a double row of five pairs of blue tubercles followed by a double row of six pairs of red tubercles.

Feeding Habits

The newly hatched larvae usually begin immediately to search for food, first feeding upon the opening buds, leaf hairs, then eating holes in the leaf tissue and in the later larval stages consuming the leaf, usually from the edges. The caterpillars, particularly the later stages, eat preferably at night and seek places of concealment from the sun in the daytime. Unlike many leaf-eating insects which confine their feeding to a single species or group of plants the gypsy moth is a general feeder on trees or shrubs. In fact in heavy infestations few species of trees are ignored, especially by the larger larvae and when food is scarce grass and cultivated crops are sometimes eaten.

The Pupae

When the caterpillars become full grown they again seek a rather sheltered location, spin a few strands of silk for support, shed their skins and transform into chestnut-brown pupae. After an average period of ten days in this stage the adult moths emerge.

The Moths

After emergence from the pupal cases the moths spend a short, quiescent period during which the bodies dry and the wings expand. The male gypsy moth is dark brown in color with black wing markings. The female is much larger than the male moth and is nearly white with black wing markings of the same pattern.

As soon as the wings are developed, usually within two hours of emergenc, depending on the weather, "assembling" begins. The bodies of the females are very heavy so they are incapable of true flight, and they remain near the empty pupal cases where they deposit their eggs. The male moths, on the other hand, are strong fliers and travel in their characteristic zig-zag flight, close to the ground or in the trees for considerable distances in search of the females.

Oviposition takes place within a day or two after the female moth emerges from the pupa and soon after her eggs are laid the moth dies completing the life cycle. There is one generation each year.

PART I

The Gypsy Moth, Massachusetts State Work, 1890-1900

Nearly 75 years ago, about 1868 or 1869, this insect which is considered one of the prime pests of forest, shade, fruit and ornamental trees in Europe was imported from France to Medford near Boston, Massachusetts, by Mr. Leopold Trouvelot who was interested in conducting experiments in interbreeding this insect with silk worms. There was no law or customs restrictions at that time to prevent entry of noxious insects. The larvae escaped from his home at 27 Myrtle Street in the Glenwood District of Medford, where the experiments were made, and became established in nearby residential and wooded areas. (Plates III and IIIa)

The increase of the pest was slow and no damage was noticed during the years immediately following. It is known that Mr. Trouvelot realized that the insect was a pest and that he gave public notice of the possible danger to tree growth if it became established. Many factors operated to prevent its rapid increase. Presumably only a relatively small number of egg clusters were imported, hence only a small number of caterpillars could have escaped and their numbers must have been greatly reduced annually in the new environment. Climatic and other conditions in Europe where the pest was collected differed materially from those in New England which caused a reduction in its normal increase. At any rate it was several years before any unusual abundance of the caterpillars was noticed in the locality and they increased from year to year but

were not reported as they were supposed to be native insects.

In the years following 1880 the caterpillars became abundant and trees on streets and residential grounds began to be defoliated. Later they became a serious nuisance in the yards and sparsely wooded areas. Just prior to 1889 they were so abundant that the efforts of the residents to bring about control by collecting the egg clusters and the larvae in cans and treating them with kerosene oil and in some cases crushing and burying them became a hopeless task owing to the density of the infestation. By this time all the trees on large areas were defoliated. Some were in a dying condition while others died and indignant protests were voiced by the residents. Specimens were finally sent to the State Board of Agriculture in Boston. They were referred to Prof. C. H. Fernald, Professor of Entomology and Zoology at the Massachusetts Agricultural College at Amherst, Massachusetts. At that time he was in Europe but the specimens were determined as the gypsy moth of Europe by Mrs. Fernald with the assistance of Dr. H. T. Fernald, their son, both of whom were trained entomologists. It was some years later that it was possible to ascertain the source from which the pest came and the reason egg clusters were brought to the United States. 1/

1/ All details that could be obtained were reported in "The Gypsy Moth" by Forbush and Fernald published by the Massachusetts Board of Agriculture, 1896, p. 1-4.

It is important to compare the conditions then existing with

the present in order to properly evaluate the problem which developed as a result of the introduction of the pest. The principal means of travel between large cities such as Boston and New York was by steam trains,most of which stopped frequently at small stations and progressed very slowly. Horse cars which were heated in the winter with wood or coal stoves, if heated at all, furnished the rapid transit facilities in large cities and connected for short distances with surrounding towns. The bodies of these cars were mounted on four wheel trucks which ran on iron tracks and were usually laid in the center of the street with occasional turn-outs to permit them to pass when moving in opposite directions. They were drawn by two horses and when grades were heavy one or two extra horses were added. The driver operated his car from a front open platform and the conductor was stationed on the rear platform. He collected the fares, signaled the driver to stop and start and acted as a bureau of general information.

A few electric cars, some of them remodeled horse cars, were operated beginning just prior to 1890 but horse drawn vehicles and a few bicycles, also the war-time practice of walking, supplied most of the passenger transportation. The first section of the Boston subway, a mile and a half in length, believed to be the first structure of its kind built in the United States, was finished and operated in 1897. Automobiles existed mostly in the land of dreams. Telephone and telegraph service for most people were luxuries and the airplane and radio had not been developed. Lighteing

facilities for buildings and streets were supplied chiefly by using kerosene lamps but in the larger places gas and electric lighting were being developed and extended toward the end of the century. Only the larger cities had water or sewer systems, and most smaller towns had wells for water supplies and one or more conveniently located town pumps with watering troughs furnished refershment for men and beasts.

The production of crops was based principally on the selection of rich soil, good seed, proper fertilization of the land and careful cultivation. Most fruit and shade trees were given little care but some attention was paid to pruning. The fruit was picked for home use or sale and imperfect material was discarded or fed to hogs. Spraying to protect crops from injury by insects or diseases wal seldom used in the New England area as it was expensive and by many was considered unnecessary. It was remarkable that such widespread interest was aroused in cleaning out this pest but this was largely due to the pride which the people took in caring for their home grounds and community centers and their great admiration for trees.

There were no insect pest laws or organizations to meet serious insect pest problems and no precedents to guide in solving them. Naturally there was widespread discussion as to what sholud be done to abate the nuisance and to prevent its widespread distribution. Public sentiment in the town of Medford demanded relief from the insect which not only defoliated and killed the trees but in some cases invaded the houses and eliminated most of the joy of living

during the caterpillar season. Statements of actual conditions furnished by eye witnesses have been published by the Massachusetts Board of Agriculture. 2/

2/ "The Gypsy Moth", 1896, pages 13-34, 40-44, also statements in later years in annual reports of the Board covering the work on this insect.

As a result of the conditions caused by the presence of the pest many residents of the infested area vacated their houses and moved to more comfortable surroundings and the owners usually found it difficult to rent or sell the property. At a town meeting held in Medford on July 15, 1889 it was voted on petition of the road commissioner to appropriate the sum of $300 for the care of shade trees. This appropriation of $300 was in addition to the usual appropriation of $500 for the same purpose made earlier in the year. It was expected under the direction of the road commissioner and men were employed to scrape the egg clusters from the trees and burn them after applying kerosene oil. In addition to the work done by the town much effort and money was expended by citizens in an endeavor to free their premises of the moth.

The efforts of the town of Medford to relieve the situation were ineffective and showed conclusively that relief must come from a well organized plan in order to accomplish effective results. At the time the insect outbreak developed and the struggle to eliminate the pest was beginning, financial and industrial conditions

were not particularly favorable. The country had not fully recovered from the effects of the nation-wide panic of 1873 and there was much unemployment. Public interest was aroused by the damage caused by this insect and many public spirited citizens, societies and groups of tree lovers insisted that effective action be taken. As a result of this attitude a state law was enacted and approved March 14, 1890 and is printed in full.

(Chapter 95)

AN ACT TO PROVIDE AGAINST DEPREDATIONS BY THE INSECT KNOWN AS THE OCNERIA DISPAR OR GYPSY MOTH

Be it enacted, etc., as follows:

Sect. 1. The governor by and with the consent of the council is hereby authorized to appoint a commission of not exceeding three suitable and discreet persons, whose duty it shall be to provide and carry into execution all possible and reasonable measures to prevent the spreading and to secure the extermination of the ocneria dispar or gypsy moth in this Commonwealth; and to this end said commission shall have full authority to provide itself with all necessary material and appliances and to employ such competent persons as it shall deem needful; and shall also have the right in the execution of the purpose of this act to enter upon the lands of any person.

Sect. 2. The owner of any land so entered upon, who shall suffer damage by such entry and acts done thereon by said commission or under its direction, may recover the same of the city or town in which the lands so claimed to have been damaged are situated, by action of contract; but any benefits received by such entry and the acts done on such lands in the execution of the purposes of this act shall be determined by the court or jury before whom such action is heard, and the amount thereof shall be applied in reduction of said damages; and the Commonwealth shall refund to said city or town one-half of the amount of the damages recovered.

Sect. 3. Said commission shall have full authority to make from time to time such rules and regulations in furtherance of the purposes of this act as it shall deem needful; which rules and regulations shall be published in one or more newspapers published in the county of Suffolk, and copies of such rules and regulations shall be posted in at least three public places in such city or town in which said ocneria dispar or gypsy moth shall be found by such commission to exist, and a copy thereof shall be filed with the city or town clerk of each city or town. Any person who shall knowingly violate any of the provisions thereof shall be punished for each violation by a fine not exceeding twenty-five dollars.

Sect. 4. Said commission shall keep a record of its transactions and a full account of all its expenditures, in such form and manner as shall be prescribed by the governor and council, and shall also make return thereof to the governor and council at such time or times and in such form as shall be directed by the governor and council. The expenses incurred under this act shall be paid by the Commonwealth, except claims for damages by the entry upon the lands of any person and acts done thereon by said commission or by its direction, which shall be paid as provided in section two of this act.

Sect. 5. The governor and council shall establish the rate of compensation of the commissioners appointed under this act, and the governor may terminate their commissions at his pleasure.

Sect. 6. Any person who shall purposely resist or obstruct said commissioners or any person or persons under their employ, while engaged in the execution of the purposes of this act, shall be punished by a fine not exceeding twenty-five dollars for each offence.

Sect. 7. It shall be unlawful for any person to knowingly bring the insect known as the ocneria dispar or gypsy moth, or its nests or eggs, within this Commonwealth; or for any person knowingly to transport said insect, or its eggs, from any town or city to another town or city within this Commonwealth, except while engaged in and for the purpose of destroying them. Any person who shall offend against the provisions of this section of this act shall be punished by a fine not exceeding two hundred dollars or by imprisonment in the house of correction not exceeding sixty days, or by both said fine and imprisonment.

Sect. 8. To carry out the provisions of this act a sum not exceeding twenty-five thousand dollars may be expended.

Section 9. This act shall take effect upon its passage. Approved March 14, 1890.

This is believed to be the first state law in the United States requiring the extermination of an insect and setting up the legal authority for entering private property for this pur-

pose and making it unlawful for any person to transport the insect into or within the commonwealth except for the purpose of destroying it. Employees engaged in carrying on the work were given legal protection and state funds were appropriated to make the law effective.

The Commission of 1890

"In accordance with the provisions of the act of March 14, Governor John Q. A. Brackett appointed a salaried commission, consisting of Warren W. Rawson of Arlington, then a prominent member of the State Board of Agriculture, Dr. Pearl Martin of Medford and J. Howard Bradley of Malden. The commission organized in Medford, March 22, with the choice of Mr. Rawson as chairman and Mr. Bradley as secretary and general superintendent. The records show that in April Mr. Samuel Henshaw of the Boston Society of Natural History was appointed entomologist to the Commission. Headquarters were established in Medford, and meetings of the commission were held almost daily until the last of July and several times per month during the rest of the year.

"The commission began its labors by a partial inspection of the known infested district, for the purpose of discovering and marking the infested trees, shrubs and other objects. The infested trees were marked with a red tag. The moth was soon found in many localities outside the restricted district to which it was at first supposed to be confined. This district did not exceed one-half mile in width and one and one-half miles in length. The inspection of

1890 justified the commissioners in the assumption that fifty square miles of territory were then more or less infested. It soon became apparent that the appropriation of twenty--five thousand dollars would be entirely insufficient for the needs of the work, chief of which was the expensive item of spraying. On May 9, in a communication addressed to Governor Brackett, the Commission reported having found the infested territory 'some sixteen times as large as first represented', and asked for an additional appropriation of twenty-five thousand dollars. This appropriation was made by the Legislature and approved June 3, 1890. The force of employees was increased, eighty-nine men being employed from June 16 to 28.

"During the month of April many eggs of the moth were scraped from the trees and destroyed by the employees of the Commission. Early in May the spraying of infested trees and foliage with Paris green was begun and continued until about the middle of July. Fifteen teams were in use, and spraying was done in Medford, Malden, Arlington, Chelsea and Everett."

An attempt was made to guard the highways leading out of Medford and Malden, with the view to preventing the further dissemination of the moth by means of vehicles. "About a dozen special policemen were employed in this duty from early in June until the last of July. They were on duty twelve hours in the day. Caterpillars were found on many vehicles going out of the infested district. Large kerosene torches were used during the summer to burn the clustering caterpillars. Considerable cutting and burning of infested trees and bushes was

also done, the chief work of this sort being in the badly infested woodland north and south of the railroad at Glenwood, Medford. About twenty acres of ground were cleared.

"In September and October a few men were engaged in scraping eggs from the trees in Medford, Malden, Somerville, Arlington, Everett, Cambridge and Chelsea. In November the force was slightly increased, and an inspection was made of certain parts of the infested territory. The cavities of some trees along the highways were closed with cement. On December 6 all men in the employ of the commission were discharged and the field work of 1890 closed." The area which had been covered by the first commission did not include all the territory which proved to be infested the following years.

This paid commission was removed by Governor Russell on February 15, 1891, and the management of the work was transferred on March 4, 1891, to another commission composed of three members of the State Board of Agriculture who served without pay. They were Professor N. S. Shaler of Harvard University, Chairman, Francis H. Appleton, Secretary, and William R. Sessions, Secretary of the Board of Agriculture. On the same day it held a conference to which were invited Professor C. V. Riley, Entomologist, United States Department of Agriculture, Professor C. H. Fernald, Entomologist, Hatch Experiment Station, Amherst, Massachusetts, Mr. Samuel Scudder of Cambridge and the mayors of cities and chairmen of selectmen in towns surrounding Boston, together with other interested citizens.

The gypsy moth problem was discussed in detail as well as the procedure that should be followed to put into effect the provisions of a new gypsy moth law which was pending. There were wide variations of opinion among those present although it was generally agreed that vigorous measures should be used to stamp out the insect. Professor Riley expressed the idea that extermination was possible provided the insect did not spread beyond the present known limits or that it had not become established in woodlands. Professor Fernald brought out the idea that if the insect could be exterminated on a few trees or a small area that the same result could be accomplished on a larger area if the necessary funds were furnished and men were trained to carry through the methods which had been found effective.

It was pointed out in the discussion that if the purpose of the work was to curtail the increase of the insect and simply prevent it from defoliating trees that this could be done much cheaper than by following an exterminative method. Professor Riley expressed the opinion that it was a waste of funds to treat egg clusters, but all of the work should be concentrated on spraying trees during the caterpillar season, preferably the first three weeks in June, and that it would be possible to exterminate the insect in one year by spraying with Paris green. The question of injury to foliage with this material and the effectiveness of this poison on the larger caterpillars was discussed. There was a difference of opinion among those present but it was agreed that

Paris green was the most effective poison for killing caterpillars that was on the market at that time.

It was agreed that more information was necessary as to the efficiency of this material for gypsy moth spraying. Mr. Scudder was very firm in his belief that effective work could be done by destroying the eggs. Professor Riley held that this was not warranted and that all efforts should be concentrated on spraying. The suggestion was made that boys be paid for scraping off the eggs and destroying them but the last suggestion by Professor Fernald that the Federal Government take over the work as it appeared that the task was greater than local authorities or the State of Massachusetts could handle. Professor Riley indicated that since the Government had established state experiment stations that it would not be advisable for the Government to take over additional work on insects. Professor Shaler expressed the opinion that the State should do the work.

The method that had been used during the previous summer of stopping vehicles to inspect them so that the insects might be destroyed if any were found on them, and which was discontinued after a short trial, was discussed and it was the opinion of most of those present that this was not a practical means of carrying on the work, but that the inspection of materials that were moved from infested areas might be effective in preventing the insect from becoming established in other localities. Considerable discussion arose relative to the banding of trees to prevent the caterpillars from reaching the foliage and the principal suggestion was that bands

made of tar paper, to which printer's ink could be applied, similar to those used for cankerworm control, might be effective. Suggestions were made that there were problems which required investigation that should be taken up and technical advice should be furnished by an entomologist who was competent to furnish needed information for the guidance of the work.

Professor Riley believed that work should be started at once to import foreign parasites to control the insect and his remarks seemed to carry the general idea that if the field work was confined to spraying in June and parasites were secured, the problem might be solved in a single year. The ideas and suggestions made at this conference were taken under consideration and it was understood that the commission would depend on Professor Fernald for advice in connection with the development of the work.

A suggestion was also made at the conference that, inasmuch as it was desirable to know how far the insect had spread, that the greater part of the work be concentrated in the area surrounding the territory previously found infested and, because the type of insect work that would be necessary in dealing with this pest was new, it would be necessary to train men to do this work effectively and requests should be made to the State Agricultural College to furnish a large number of men to carry on field work on this problem and be the nucleus for an effective force.

March 12, 1891, Mr. Edward H. Forbush was appointed director of field work.

The gypsy moth law of 1890 was repealed and the following law was enacted by the Legislature and approved April 17, 1891:

(Acts of 1891, Chapter 210)

AN ACT TO PROVIDE AGAINST DEPREDATIONS BY THE INSECT KNOWN AS THE OCNERIA DISPAR OR GYPSY MOTH

Be it enacted, etc., as follows:

Sect. 1. The state board of agriculture is hereby authorized, empowered and directed to provide and carry into execution all reasonable measures to prevent the spreading and to secure the extermination of the ocneria dispar or gypsy moth in this commonwealth; and to this end said board shall have full authority to provide all necessary material and applicances, and to employ such competent persons, servants and agents as it shall from time to time deem necessary in the carrying out the purposes of this act; and said board shall also have the right itself or by any persons, servants or agents employed by it under the provisions of this act to enter upon the lands of any person.

Sect. 2. The owner of any land so entered upon, who shall suffer any damage by such entry and acts done thereon by said state board of agriculture or under its direction, may recover the same of the city or town in which the lands so claimed to have been damaged are situate, by action of contract; but any benefits received by such entry and the acts done on such lands in the execution of the purposes

of this act shall be determined by the court or jury before whom such action is heard, and the amount thereof shall be applied in reduction of said damages; and the Commonwealth shall refund to said city or town one-half of the amount of the damages recovered.

Sect. 3. Said state board of agriculture shall have full authority to make from time to time such rules and regulations in furtherance of the purposes of this act as it shall deem needful, which rules and regulations shall be published in one or more newspapers published in the county of Suffolk; and copies of such rules and regulations shall be posted in at least three public places in each city or town in which said ocneria dispar or gypsy moth shall be found by said board to exist and a copy thereof shall be filed with the city clerk of each such city and with the town clerk of each such town; and any persons who shall knowingly violate any of the provisions thereof shall be punished for each violation by a fine not exceeding twenty-five dollars.

Sect. 4. Said state board of agriculture shall keep a record of its transactions and a full account of all its expenditures under this act, and shall by its chairman or secretary make report thereof, with such recommendations and suggestions as said board shall deem necessary, on or before the fourth Wednesday in January, to the general court.

Sect. 5. Said state board of agriculture shall establish the rate of compensation of any persons, servants or agents employed by it under this act.

Sect. 6. Any person who shall purposely resist or obstruct said state board of agriculture, or any persons, servants or agents employed by it under the provisions of this act, while engaged in the execution of the purposes of this act, shall be punished by a fine not exceeding twenty-five dollars for each offence.

Sect. 7. It shall be unlawful for any person knowingly to bring the insect known as the ocneria dispar or gypsy moth, or its nests or eggs, within this Commonwealth; or for any purpose knowingly to transport said insect, or its eggs, from any town or city to another town or city within this Commonwealth; Any person who shall offend against the provisions of this section shall be punished by a fine not exceeding two hundred dollars or by imprisonment in the house of correction not exceeding sixty days, or by both such fine and imprisonment.

Sect. 8. The said state board of agriculture may exercise all the duties and powers herein conferred upon said board, by and through its secretary and such members of said board as it may designate and appoint to have in charge, in conjunction with its secretary, the execution of the purposes of this act.

Sect. 9. All moneys heretofore appropriated or authorized to be expended under the provisions of chapter ninety-five and one hundred fifty-seven of the acts of the year eighteen hundred and ninety or by/~~any~~other act, and not heretofore expended, are hereby

appropriated and authorized to be expended by the said board in carrying out the purposes of this act.

Sect. 10. All the property acquired and records kept under the provisions of said chapter ninety-five of the acts of the year eighteen hundred and ninety shall be delivered into the custory of said board, and said board is authorized to take, receive and use the same for the purposes of this act.

Sect. 11. Chapter ninety-five of the acts of the year eighteen hundred and ninety is hereby repealed, but all claims for damages under said chapter ninety-five for entry upon and acts done on the lands of any person may be prosecuted, as therein provided, against the city or town wherein the lands entered upon are situate, and the damages shall be ascertained and one-half of the amount thereof recovered against any city or town shall be refunded to such city or town as provided in said chapter ninety-five. (Approved April 17, 1891.)

At a special meeting of the Massachusetts Board of Agriculture held April 28, Messrs. Sessions, Shaler and Appleton were appointed a committee to take charge of the work. This committee organized on May 19 and Mr. Sessions was chosen chairman and secretary. The committee continued the work which it had begun as a commission. Rules which had been in effect in carrying on the work of the first commission were revised and amplified and served as a guide with such modifications as were needed from time to time during the continuance of the work. They are quoted below:

REVISED RULES AND REGULATIONS ADOPTED BY THE STATE BOARD OF AGRICULTURE

(Under Chapter 210, Acts of 1891)

Rules and Regulations for the Public

1. All persons are forbidden by law to remove the eggs or any other form of the gypsy moth from one city or town to another, and are requested to exercise care against so transporting the gypsy moth on teams and carriages.

2. All persons are forbidden to remove from any locality in the towns of Medford, Everett, Chelsea, Malden, Melrose, Cambridge, Winchester, Somerville and Arlington any hay, manure, wood, bark, trees, rags, lumber or shrubbery of any kind, without a written permit from the Board of Agriculture. Persons desiring to remove such materials will notify the field director, 13 Stanwood Hall, Malden.

3. All persons are forbidden to in any way imitate or erase the marks employed by this Board to designate trees, fences or buildings which are infested or have been cleaned.

4. All vehicles leaving the above-named district may be stopped by the officers of the Board and delayed until their contents have been sufficiently inspected to determine the fact that they are not liable to transport the eggs or any other form of the insect.

5. No person shall trim, scrape or cut down trees within the district known to be infested by the gypsy moth, or remove them without first notifying this Board, and having said trees thoroughly in-

spected, and, if found infested, cleaned under its direction.

The eggs of the gypsy moth are frequently scattered abroad by scraping the trees and by careless gathering; therefore, all persons except the authorized agents of this Board are forbidden to remove the eggs of the gypsy moth from the trees or other objects upon which they may have been deposited, or to remove such infested trees or objects from one place to another.

Land owners and tenants are requested to destroy all other forms of the moth which they may find upon their premises.

6. All persons, upon notice, are required to confine their dogs while the agents of this Board are at work upon their premises.

7. Owners or tenants are requested to gather and burn all rubbish and useless material upon their premises that may provide nesting-places for the gypsy moth, and to fill with cement or other solid material all holes in trees upon their premises.

8. All persons are requested to keep the windows of their houses protected by screens during the summer months, as the moth often lays its eggs in houses, wherever it can gain admittance.

9. All persons having reasonable cause to believe that the eggs, caterpillars or other forms of the gypsy moth exist on or about their premises are earnestly requested to forthwith notify E. H. Forbush,

director, by letter addressed to his office in Malden, Mass. Information of the moth's existence in isolated or unsuspected localities will be gratefully received, and all persons furnishing such information will receive the thanks of the Board.

10. Notice is hereby given that it will, in some cases, be necessary to remove boards from fences or buildings. In all cases such boards will be eventually replaced, if possible, without damage to the structure. Attention is called to the fact that any damage done by the agents or servants of this Board, in the work of exterminating the moth, may be recovered under provisions of section 2, as above printed.

Attention is also called to section 6, as above printed, which sets forth the penalties for obstructing any servant or agent of the State Board of Agriculture under this act.

11. Courteous and considerate conduct is expected of all agents and employees of the Board. Complaints in writing concerning any infraction of this rule should be sent to the director, and will be heard by him or the committee.

Rules and Regulations for Agents and Employees

It shall be the duty of employees to familiarize themselves with the rules governing the gypsy moth work. The violation of any of the rules will be sufficient cause for discharge at any time without notice.

General Rules

1. No person will be employed or retained who is known to use intoxicating liquors as a beverage.

2. Smoking is strictly prohibited during hours of labor.

3. Courteous and considerate conduct is required of all agents and employees of this Board.

4. All agents and employees (unless otherwise ordered by the director) must wear at all times during working hours the uniform caps and badges issued by the quartermaster.

5. Employees must provide themselves with the uniform prescribed by the State Board of Agriculture and said uniform must be worn during working hours.

6. No employee shall sign the payroll for another unless he has a written order from the person for whom he signs. Said order must be made out on one of the blanks furnished by the Board and must be sent with the payroll to the director's office.

7. Superintendents and inspectors are empowered to recommend men for employment, promotion or discharge. Deliquents should be sent with a sealed note of explanation to the office.

8. If an employee is unsatisfactory in any way, the inspector

or other officer immediately in authority over him should inform him at once of the fact and note it on the report of that day.

9. If men are delayed in getting to work by the lateness or negligence of an inspector or a teamster, or if any inspector shall order or allow his men to cease work before the regular hour, said inspector or teamster will have the hours lost by himself and the men deducted from his time, and superintendents shall report the facts of the case.

10. Employees before signing receipt for tools should assure themselves that the numbers on the tools and receipts agree.

11. If a transfer of tools from one employee to another is made in the field, the tools will remain charged to the man who took them from the storehouse, unless a record of such transfer is taken in or mailed to the office within twenty-four hours of the time of such transfer. Unless such notice is received, the employee to whom the tools were originally charged will be held responsible for them.

12. Inspectors may use time cards, when necessary, as a medium for ordering tools.

13. Drivers and owners of wagons are responsible for tools committed to their charge.

14. An employee leaving the service of this Board must at once return to the quartermaster all property of the Commonwealth which has been in his charge. Otherwise, the full value of the same will be deducted from his wages then due.

Rules for Inspecting Sections, Marking Trees and Destroying Eggs

15. Each inspector must keep in his note-book a complete record of all work done in his section. This book is to be returned to the director's office when called for, and to be left there when the inspector's term of office expires.

16. Each inspector must carry his section map with him in the field and locate upon the map (by means of such marks as may be ordered by the director) each tree or locality that he finds infested.

17. Each tree found infested must be at once marked with such characters as may be designated by the director, the mark to be on the trunk at three points equidistant from each other and five feet from the ground.

18. When a tree is found infested which has been marked in a previous season, the new mark is to be placed two inches above each of the latest marks.

19. Each object on which egg clusters of the gypsy moth are found in "outside towns" must be marked with a spot of white paint

the size of a ten-cent piece, this spot to be within an inch of each egg cluster. Egg clusters found in woodland must be surrounded with a ring of white paint.

20. No trees on highways, in orchards or upon grounds about residence are to be cut, burned or trimmed unless it is found to be actually necessary. In every case where a large branch is cut off the stump must be covered with coal-tar. Trees must not be cut down unless written permission is obtained of the owner, or unless it is so ordered by the director.

21. Each inspector will pay special attention to the trees and shrubbery along the lines of railroads in this territory. The ground around railroad stations must be carefully inspected.

22. Inspectors are not to call at the office except to leave reports, or unless by special order of the director.

23. Each inspector or acting inspector having charge of two or more men will form his men in line and call the roll at seven a.m. at the place where he begins work. He will again form them in line and call the roll at the close of the day's work.

24. When the roll is called at night inspectors must state distinctly to their men the point at which they will call the roll on the following morning, and any employee who fails to answer this roll-call will not be allowed full time.

25. Employees will exercise great care that they do not carry living larvae from place to place either on their vehicles and clothing or in any receptacle.

26. When employees under the direction of an inspector are obliged to injure or destroy any property, or when property is accidentally destroyed, or accidents of any kind occur, the facts must be reported at once to the inspector, and he must make a note of the same in his report, giving an estimate of the amount of damage done and names of all witnesses.

27. Inspectors must note (and ask their men to note) and state in their reports the language and means used by persons obstructing their work.

28. When troublesome dogs are encountered inspectors may require the owners to confine them, under penalty of the law.

29. Employees must not leave ladders standing or lying by the curbstone in the street. They must be taken down when not in use and removed to some safe place. Care must be used in handling ladders and also in climbing trees, not to break or otherwise injure the branches.

30. Employees must exercise great care in blazing trees. The inner bark should never be cut.

Fires

31. No fires shall be kindled except by order of the dividon superintendent.

32. Superintendents will demand that due caution is observed in the kindling and management of fires. They will see that the necessary applicances are at hand for the management and extinguishing of all fires ordered kindled. Inspectors in charge will be held responsible for the proper management of fires, or if fires are left at the close of the day's work without being extinguished.

33. No fires are to be build upon sidewalks, or near the curbstones in the streets.

Spraying

34. Inspectors must notify pedestrians not to walk under trees which are being sprayed, and must avoid spraying on vehicles.

35. In spraying always station the tank to windward of the sprayers, so that the spray may not blow over it.

36. Before beginning work on an estate inspectors must request occupants to take clothing from lines, close windows and remove any thing that may be any possibility of injuring by spraying.

37. Employees must use great care not to injure lawns, flowerbeds, vegetable gardens or other property.

38. Inspectors are to handle and mix poisons.

39. The solution in the tank must be constantly stirred from the time it is first mixed until the tank is empty.

40. Tanks must be fastened on the wagons in such a way that they cannot be overturned.

41. If, during the spraying, a tree is found infested and unmarked, it must be marked. Each time a tree is sprayed it must be marked with three round dots, the size of a ten-cent piece, the first set being placed five feet from the ground, and each succeeding set an inch above.

42. Inspectors will carefully notice the effect of the spraying and record the same in their daily reports.

43. The spray thrown on the trees must be as fine as possible.

44. Drivers of spraying wagons, when at work, will be under the direction of the inspector in whose section they are employed. Each inspector will keep the time of the driver and report the same.

45. Inspectors must, when possible, draw water from the standpipes. When hydrants are used the inspector only shall open and close them, exercising great caution to open and close them slowly, but not closing them so tightly as to prevent opening.

46. At morning and at noon, before beginning spraying, each nozzle must be turned into the bottom of the tank and a full stream pumped for five minutes.

Reports

47. The rating of superintendents and inspectors will be based, not only on the quality of the work done by their men, but on the fulness and excellence of their own reports. All reports must be sent to the director's office and are subject to his approval. Each inspector must make out his report daily and give it to his superintendent, or send it to the office (by mail or otherwise) on the following day. Observations on the habits of the insect and other items of interest, and any statements or complaints by citizens, should be embodied in the reports.

48. Superintendents must notice whether the streets are reported in their proper sections.

49. Inspectors must give time of employees on each day's report.

50. In case of the absence of an employee the inspector must give the reason (when known to him) for such absence on the report of the day when such absence occurs.

51. Inspectors must observe the printed headings on reports and fill spaces reserved under the same.

52. Inspectors must give the correct street and number of each building and estate inspected and the full name of the property owner or tenant.

53. If at work in two or more sections in a day, inspectors must make a separate report for each section.

54. The name of the inspector, if at work, must appear in the employees' column.

55. When a man enters the employ of this Board the inspector with whom he first serves shall make note of it at the time on his daily report.

56. Each inspector will designate on each day's report and time card the exact point at which he will begin work on the next working day and on what street and in what direction he will move; also the exact hour and place of roll-call and the place designated for roll-call the following morning.

57. Whenever a marked tree is cut the inspector in charge shall incorporate the fact (giving marks) in his daily report.

58. Inspectors will report as trees all young growth above three inches in diameter.

59. When brush is cut and ground burned over inspectors will re-

port in square yards the area cleared daily.

60. If men are sent away on special duty by an inspector he must state the reason on his report and mark time cards"see report" opposite such names.

61. Superintendents, special inspectors and all other assistants in the field must state on their daily reports when and where they meet their men; and inspectors must also note on their reports the times of such visits.

Per order of the committee,

E. H. Forbush, Director

The law and the rules and regulations cited laid the foundation for the organization of the work. One of the first tasks was to prepare maps of towns and cities for field and office use. In most cases they were enlarged and divided into sections. On these were recorded the work done, all of which was backed up by detailed reports indicating the location of all colonies of the insect that were found and the treatment applied. This method of keeping records, with some minor changes, was continued for the duration of the work.

Organization of the Work

Aside from the committee of the State Board of Agriculture which was responsible for the administration of the work and served without salary and the Entomologist who was advisor to the Board the setup of

the operating force was as follows:

Director	$2400 per annum
Assistant Director	$3.50 " day
Division Superintendent	$3.50 " "
Agents	$3.00 " "
Special Inspectors	$2.75 " "
Inspectors	$2.50 " "
Scouts	$2.25 " "
Privates	$2.00 " "

The entrance pay for privates for the first two weeks was $1.50 per day. If their services were satisfactory at the end of that period, they received the regular $2.00 rate. In addition to the above, there was a quartermaster who had charge of the property and also acted as paymaster, as the men were paid in cash in the field. One man assisted the quartermaster in issuing and handling material in the storehouse. A small clerical force was also employed at the office.

Per diem employees were paid for time actually employed, based on a nine-hour day and six-day week with no pay allowance for holidays or Sundays. As the major expenditures for work of this type were for personal services a much larger volume of work was secured with the same number of men than is possible under present conditions. The Director and Assistant Director carried on the administrative and advisory work.

The territory was divided into four divisions with a superintendent who supervised the work in each. A few agents were employed for special assignments usually having charge of expert scouting work in the oustide territory. Special inspectors were assigned to the different divisions to check up the work which was being carried on. They reported direct to the office. Inspectors had charge of crews of scouts or privates, depending on the type of work which the men were doing in the area to which they were assigned.

The experimental staff which worked under the general direction of the Entomologist of the Board, normally consisted of one entomologist in charge of the laboratory with one trained entomologist as assistant. For several years a chemist was employed who handled experimental work on insecticides and, during the summer, additional assistants were necesary to take care of seasonal work. The pay of these men corresponded in general with the rates already cited.

The most capable men who had previously served on the work were reemployed in 1891. As fast as men were hired they were grouped in squads of approximately ten men and given instructions as to their duties and the methods that were used in inspecting trees and other objects to determine whether infestation existed, making records, keeping the time of any men assigned to them and the reasons why the rules and regulations must be strictly compiled with.

Prior to employment they were required to report for an eye test and demonstrate their ability to locate egg clusters, to shin trees

and climb with ladders and ropes as well as their physical suitability for the work. If they met these requirements they were assigned to work in a division. In addition to field examinations, treatment of egg clusters and other field work, certain police regulations were enforced during June and July 1891, which consisted in stopping vehicles in making examinations to determine whether they were carrying caterpillars from infested to non-infested areas. After a trial of this method for a few weeks, it was abandoned because the results did not warrant the expenditures. Some spraying was done by using improvised equipment. Paris green was used as poison at the rate of one pound to 150 gallons of water, and before the season was over 30 horse-drawn wagons carrying spraying outfits were operated in the field, but the number was not sufficient to treat all the infestations. The use of Paris green was not entirely satisfactory on account of the tendency of this material to burn the foliage, particularly the leaves of tender trees and shrubs and the difficulty in keeping it thoroughly mixed with the water in the tanks. In some cases even two applications failed to prevent defoliation. (Plates IV and IVa)

Considerable opposition resulted from its use by the people living in infested towns. A mass meeting of protest was organized to prevent further spraying and there were cases of mutilating the host and threats of violence which resulted in some arrests and fines. The preparation and circularization of bulletins, explaining the methods of treatment and pointing out their advantages, did not prevent continued protests and opposition. Burlap bands were tried on trees to form an artificial shelter for the caterpillars, large numbers of

which were crushed during the season. In spite of difficulties progress was made on the work, large colonies of the moths were destroyed and most fruit and shade trees given fairly good protection. There were some areas that could not be treated before the end of the feeding season and complete defoliation occurred. (Plates V and Va)

During the spraying season Professor Riley and Mr. Samuel Henshaw visited the district and surveyed the field operations. It became evident before the end of the season that although spraying greatly reduced the number of moths, the methods practiced could not be relied upon as a means of complete extermination for many caterpillars survived the treatment and foliage in some sections was badly burned.

Millions of trees were inspected and treated and over 750,000 egg clusters were found and destroyed prior to hatching in 1891.

Experimental Work

On June 18, 1891, Prof. C. H. Fernald was appointed Entomologist to the committee, and Dr. E. P. Felt, one of his assistants, was assigned to make observations and carry on experiments. In addition to this work, which indicated that several native natural enemies were feeding to some extent on the gypsy moth, observations and suggestions made by field inspectors resulted in improvements in some of the methods which were used in treating infestations. These improvements were put into effect after being tried in a small way and tested in the field to determine their usefulness.

At the end of the calendar year the appropriation was nearly exhausted, but recommendation for an appropriation of $75,000 was made to carry on the work for the next year. It was believed that this was as much as could be used to advantage owing to the difficulty of organizing the details of the work and the need for tests to determine better and more satisfactory methods of treatment than those that had been hastily assembled for the emergency.

A summary of the methods used at this time may be appropriate. They included the destruction of eggs by scraping them from the trees and burning them in kerosene, (By the end of the year saturating the egg clusters with creosote was substituted as it was found more effective); destruction of caterpillars by spraying with Paris green at the rate of one pound to 150 gallons of water; use of sticky bands to prevent the caterpillars from crawling up the trees and crushing those that assembled beneath the bands; use of burlap bands (Plate VI) which furnished a hiding place for the caterpillars and made it possible to crush large numbers in heavy infestations; filling cavities in trees with cement where egg clusters were concealed so as to prevent hatching and escape of caterpillars; removal and burning of dead trees and branches which afforded places of concealment for egg clusters and caterpillars; and use of torches to burn out stone walls and areas where ledges and stones offered suitable places for concealment of egg clusters, the latter treatment being applied immediately after hatching and was useful in special areas. All of these methods were improved from year to year as the work proceeded, and further mention will be made of such improvements and changes later in this report.

Rumors and complaints were received from over twenty-five towns and cities beyond the infested area indicating that the insect was present, all of which proved to be erroneous. Similar reports were received and investigated annually and in only a very few cases the gypsy moth was found. The attached map indicates the towns where infestations were found. (Plate VII) Many of the towns on the outside border had only a few infestations which were promptly exterminated.

1892

In 1892 the appropriation of $75,000 was delayed so that the force of men was not as large as it should have been in early spring when excellent results can be secured in treating egg clusters before they hatch. Previous experience had determined that Paris green was not very efficient unless used at a strength which severely injured the foliage. On this account only a few areas were treated. The use of raupenleim, a banding product imported from Germany, made it possible to treat many trees where spraying could not be done. This material proved superior to other products prepared for the same purpose by American manufacturers. Burlap bands were uses extensively. Treatment of egg clusters with creosote gave satisfactory results.

Observations were made in the field to determine whether any native parasites or predators were attacking the moth, but few species were collected. Information was secured indicating that a few species, particularly Hymenopterous parasites, had been listed as enemies of the insect in Europe.

A tabulation of estimated damage to various staple crops in the United States by insect pests, most of which were of foreign origin, was published by Professor J. A. Lintner, State Entomologist of New York, and showed that tremendous losses resulted, in many cases amounting to millions of dollars. This data was secured from the leading entomologists in the United States and Canada and it was reasonable to suppose that the gypsy moth might cause comparable damage if it continued to develop without restraint.

In spite of the loss of time in carrying on the work, due to reduced and late enactment of the appropriation, sufficient progress was made to convince the management that the extermination of the insect was possible if sufficient funds were promptly made available so that a definite program could be planned and followed. It was suggested that Federal aid should be secured on this undertaking.

1893

A financial panic swept the country in 1893 and caused serious dislocation of business and widespread unemployment.

Estimates for an appropriation of $165,000 were made for the calendar year beginning January 1, 1893, and an additional $2,000 was requested to meet the expense of the collection of data in Europe and America to supplement information already secured so that a comprehensive report on the gypsy moth could be published as soon as possible, in order to bring information on the insect up to date and in-

dicate the best methods of attacking the problem. Authorization to assemble as much data as could be secured had been given the entomologist by the committee.

Although most of the people of the infested area favored the work there was only a mild interest in other parts of the state or in the country at large, with the exception of experts who were familiar with insect problems and realized the potential danger which would result to all sections of the United States where the insect could maintain a foothold. There were some individuals who for one reason or another, directly or indirectly, opposed the work. One phase of this opposition is shown in an article which appeared on March 4, 1893, in the "Massachusetts Ploughman",

"The Gypsy Moth

Editor, Mass. Ploughman: - Dear Sir: Again the question of the gypsy moth is brought before the people of this Commonwealth by the report of the State Board of Agriculture recommending our Legislature to appropriate the sume of $165,000 to be used during the current year toward the extermination of this remarkable insect pest, which had derived its chief claim to state recognition on account of the exhaustive researches of our learned State Commission.

Granted that the gypsy moth is a dangerous pest, why in the name of common sense, and of economical and sensible government, should the state be expected to appropriate large sums

of money year after year to protect individuals in a matter which is entirely personal in its nature, and not within any reasonable conception of the proper functions of the state? Let every energetic and thrifty property owner look after his own real estate, let him protect it against all natural invasion, insectivorous or otherwise. Individual self-reliance should be encouraged and state aid ought not to be expected or invoked in a question of this kind. There is no more reason for expecting the state to protect its members against damage done by injurious insect life than there is to expect the state to interfere in the management of one's private business. Let our Legislature abolish this Gypsy Moth Commission, refuse to appropriate a single cent for the perpetuation of such a ridiculous fraud on the community, and we will soon hear nothing further about this remarkable gypsy moth with its prodigious appetite and reproductive power. Let the gypsy moth be relegated to the same treatment as other insect pests, such as tent caterpillars and canker worms have received in this Commonwealth for generations, and let the whole question remain one of individual care and attention. Hunting for moths' eggs with miscroscopes and spyglaases will never cease with this Commission until the State's generosity and the people's patience are exhausted.

If this whole question is only withdrawn from the arena of politics, the gypsy moth will simply assume its proper position

with all our other insect pests. Let each property owner look out for his own estate and then there will be no further need for state interference or public expenditure for the extermination of the gypsy moth.

(s) Varnum Frost"

Belmont, Feb. 26, 1893

An appropriation of $100,000 was authorized by the legislature on April 12, 1893, for the current calendar year, and a resolve was sent to Congress by the legislature asking for $100,000 for the gypsy moth work in Massachusetts. In connection with this matter the following quotation from the annual report of the gypsy moth committee covering the year 1893, but published in 1894, is of interest:

"It will be remembered that the Legislature of 1893 by resolve requested 'The Senators and Representatives from the Commonwealth in the Congress of the United States to urge upon Congress the necessity of prompt and vigorous action to exterminate said pest (gypsy moth), and to use their influence to secure from Congress an appropriation of one hundred thousand dollars to assist the Commonwealth in defraying the necessary expenses of the work.' A committee was sent to Washington to assist in the matter by interviewing the Secretary of Agriculture, the committees on Agriculture and Appropriations. From what this committee could learn and from recent communications from the Secretary of Agriculture, we are satisfied that no assistance can, for the present at least, be expected from the general government."

Over 800 colonies were exterminated during the year but several large colonies were found in woodland in the central infested region and three small isolated colonies were discovered just beyond the known infested area in Burlington, Danvers and in Franklin Park, Boston. Intensive work was done in these colonies.

During the summer specially constructed traps (Plate VIIa) were used containing virgin female moths for the purpose of attracting males, to determine whether the fertility of egg clusters in the vicinity of the traps was lessened by the destruction of the males. The results were negative.

In view of the unsatisfactory results secured by using Paris green as a spray, experiments were carried on with various arsenites. The results were not very satisfactory, but by using water solutions of sodium arsenate and acetate of lead to produce arsenate of lead promising results were secured. Glucose was added in the spray tank with the idea that it would cause the poison to adhere more firmly to the foliage. This work was done by Mr. F. C. Moulton, a chemist, who was employed by the committee. Later work on this material and other compounds made possible the development of arsenate of lead as an effective insecticide.

In June the following entomologists visited the gypsy moth infested area for the purpose of examining the work, determining its efficiency and suggesting any improvements which might be made. They were: Prof. A. S. Packard, Brown University, Providence, Rhode Island;

Dr. J. A. Lintner, State Entomologist, Albany, New York; Dr. John B. Smith, State Entomologist, New Brunswick, New Jersey; Prof. Clarence M. Weed, Entomologist, Agricultural Experiment Station, Durham, New Hampshire; Dr. H. T. Fernald, Pennsylvania State College, State College Pennsylvania; Prof. J. H. Comstock, Cornell University, Ithaca, New York, was also invited to inspect the work but was unable to do so at that time. They made some suggestions relative to operations which were adopted as far as practical by the Committee and expressed themselves distinctly in favor of the continuation of the work to complete the extermination of this insect. The reports were made individually and have been published in full. (Appendix A) (See page 78)

This policy of inviting the best experts on entomological work to inspect the work and offer any suggestions which they might have relative to its improvement was adopted by the committee, and as a result of this, it was possible for them to secure opinions and suggestions which were extremely valuable as the work progressed.

1894

Early in the year Professor N. S. Shaler, who had been a member of the committee from the time of its origin in 1891, was obliged to resign from the Board of Agriculture on account of the pressure of other duties. Mr. Francis H. Appleton, who had been a member since the appointment of the committee, resigned from the committee in May. These gentlemen were in perfect accord with the other members of the committee, and all previous plans had been carried out with the unanimous approval of all of the members.

On January 16 the State Board of Agriculture was instructed to report to the General Court the following facts and estimates relative to the gypsy moth exterminating work:

1. The amount appropriated and amount expended annually for such purpose since the work began.

2. The amount per year which would be necessary, in the estimation of the Board, to expend upon such work during the next ten years.

3. Whether, in the Board's opinion, it would be necessary to continue extermination work for an indefinite period.

4. If not necessary to continue such work indefinitely, what would be the probable limit of time necessary to continue, and the probably cost after ten years.

The Board replied to the Legislature that appropriations were as follows:

March 14, 1890	$25,000.00
June 3, 1890	25,000.00
June 3, 1891	50,000.00
1892	75,000.00
1893	100,000.00
TOTAL	275,000.00

Expenditures each year were listed as:

In 1890, by the First Commission	$25,539.32
In 1891, by the Second Commission	13,457.46
In 1891, by the State Board of Agriculture	55,790.09
In 1892, by the State Board of Agriculture	74,540.96
In 1893, by the State Board of Agriculture	75,927.48
Total expended to January 1, 1894.....	$245,255.31

The Board estimated, in answer to the second question, as an opinion only, that if $165,000 were appropriated for 1894, $150,000 for 1895, $100,000 for 1896, $50,000 for 1897 and $25,000 each year for the following five years to be used for inspection of the territory, the gypsy moth could be exterminated. If only $50,000 were to be appropriated each year the Board believed the work would have to be continued indefinitely. Since the estimate for cost of extermination covered a period of nine years, the answer to the third and fourth questions was given in the answer to the second question.

At the annual meeting of the State Board of Agriculture on February 8, 1894, the Board was reorganized and the committee in charge of the gypsy moth work was changed to the "committee on the gypsy moth, insects and birds". Its number was increased to six,the following were elected to serve: E. W. Wood of Newton, Chairman; William R. Sessions of Hampden, Francis H. Appleton of Peabody, William H. Bowker of Boston, F. W. Sargent of Amesbury and Augustus Pratt of North Middleborough.

The Board recommended an appropriation of $165,000 for the year and the committee on agriculture of the Legislature reported a bill providing for this amount. The Legislature finally acted on a bill reported by the Committee on expenditures carrying only $100,000 which did not become available until May 23. In the meantime, funds carried over from 1893 became exhausted and all field work ceased on May 1 and Mr. Appleton, one of the original members of the gypsy moth committee, resigned. Mr. Appleton gave as his reasons for resigning that inasmuch as the Board had stated a certain sum must be available to do the work, the sum appropriated was not sufficient to comply with the requirements of the law and he felt it incumbent upon him to resign rather than attempt an impossible task.

The use of arsenate of lead, which appeared to give satisfactory results when tested in a small way in 1893, was used on a limited scale during 1894. It proved effectual in destroying other insects, but did not kill all the gypsy moth caterpillars on trees that had been sprayed with this poison at the rate of 15 pounds of freshly precipitated arsenate of lead to 150 gallons of water. When the strength was increased to 30 pounds with the same amount of water, all caterpillars were destroyed. This material did not burn the foliage, even with the stronger dosage, but its cost when used in this proportion was much more expensive than Paris green and did not destroy the caterpillars as quickly. The results indicated that further work needed to be done with arsenate of lead as it appeared to be a promising insecticide.

Large numbers of trees were burlapped, totaling more than 600,000 during the summer, and satisfactory results were obtained. A study of traffic conditions together with the type of material that was moved by vehicles was made for the purpose of determining the danger of movement of the insect from infestations which had not been entirely cleaned up. A few egg clusters were found as a result of this work, and the locations were treated, which resulted in their prompt extermination.

Additional information was secured relative to native natural enemies of the moth in this country and an additional number of birds and parasites and predators were added to the list that had been accumulated.

The committee, in its report for the year to the Legislature, stated that the moth had apparently been exterminated in ten of the outer towns and very nearly exterminated in five more. More than a thousand colonies had been stamped out and such sections of all the infested towns that had been worked over year by year were nearly cleared of infestations.

Against this favorable condition it was reported that after inspection of many towns the woodlands were found to be more generally infested that it had been supposed. Scattered colonies were found in woodlands over a wide belt due to the fact that insufficient money had prevented thorough search. The Board again deplored the failure

of the Legislature to appropriate the requested funds so that means could be taken to comply with the law. It concluded its annual report with a recommendation for $200,000 for work in 1895 or that the law be changed, if a less sum were to be appropriated, so that prevention of spread only should be required.

The following statement appears in the report of the entomologist relative to the policy of exterminating the gypsy moth:

"There are some who believe that this insect can never be exterminated, but that the best thing to be done is to make a moderate annual appropriation to hold it in check, which means a perpetual warfare and a perpetual expense. Those who have been most familiar with the various infested towns, are positive in their convictions that it is not only possible but feasible to exterminate the gypsy moth in the region known to be infested, in a term of years, if sufficient annual appropriation be made for this purpose. The sum total of these appropriations for the term of years required may seem large; but when compared with the sum total of a perpetual annual appropriation sufficient to hold this insect in check, it sinks into utter insiginificance.

"It will undoubtedly be a stupendous undertaking to exterminate this pest, and will cost much more in the end than it would if the full appropriations asked for by the committee had been granted; but, nevertheless, it will be a far wiser policy to make the necessary appropriations for a term of years and completely exterminate the insect, than to allow it to become a perpetual expense to the people of this Common-

wealth as well as to the whole country."

Early in the summer the following entomologists were invited to visit the territory, inspect the work, and give any suggestions that might be useful relative to its continuance: Prof. F. L. Harvey, Maine State College, Orono, Maine; Dr. G. H. Perkins, Unviersity of Vermont, Burlington, Vermont; Prof. J. H. Comstock, Cornell University, Ithaca, New York; and Dr. L. O. Howard, Entomologist of the Department of Agriculture, Washington, D. C.

Every facility was furnished so that they could familiarize themselves with the problem and the work that was being done, also the equipment that was used, methods which were employed in destroying the insect, and various experiments which were under way. A report was received from each of the gentlemen mentioned and they are published in full in Appendix B. (See page 89)

1895

The Legislature of 1894 had adopted a resolve requesting the senators and representatives from Massachusetts in the Congress of the United States to use their influence and urge Congress to appropriate $100,000 to assist the State in its work for extermination of the gypsy moth. The Senate agriculture committee held a hearing on this resolve on January 4, 1895 and on January 5 the committee on agriculture of the House of Representatives held a special hearing on a resolution introduced by Hon. William Cogswell which provided for the appropriation asked for.

Mr. Appleton, vice-president of the State Board of Agriculture, Mr. Sessions, its secretary, and Mr. Forbush represented the Board at these hearings. Later the United States Senate passed a resolve providing $40,000 but this was defeated in a conference committee and the attempt to secure Federal funds came to naught.

At the annual meeting of the State Board of Agriculture on February 6, 1895, Mr. William H. Bowker, a member of the committee on gypsy moth, insects and birds, retired at the expiration of his term on the board. This vacancy and that left by the resignation of Mr. Appleton from the committee in 1894 were filled by election of Messrs. John G. Avery of Spencer and S. S. Stetson of Lakeville. The committee continued to hold regular meetings every two weeks and there were numerous special meetings throughout the year.

Upon presentation by the Board of Agriculture of its recommendation for an appropriation of $200,000 for work in 1895, considerable opposition developed in the legislative committee on agriculture. Hearings were held beginning February 11 and hundreds of interested citizens attended who were preponderantly in favor of granting the Board's request.

The committee finally reported a bill providing $150,000, which the Board considered inadequate but, nevertheless, they urged its passage to avoid further delay which seemed as dangerous as the reduction from the amount recommended. But it was not until May 17 that even this became available. The field force had been discharged

on February 6 when funds from 1894 were exhausted and, as a result of the delay, over three months of working time was lost. This loss of time was especially disastrous because the season was, it proved later, particularly favorable for increase of the moth.

In June 1895 the author started on the gypsy moth work, being assigned to a scouting crew.

Hatching occurred earlier than usual this year and, contrary to any previous record, a small second brood of larvae appeared during the first weeks in September. These larvae fed and grew slowly but all perished eventually.

An unusually large number of trees were burlapped and, by the use of this method, the infestation was reduced in many localities. Freshly percipitated arsenate of lead was sprayed on the foliage and as much as 30 pounds to 150 gallons of water was used without causing injury but some of the large caterpillars survived.

Small infestations were found throughout the woodland areas particularly in the territory between Lexington and Lynn, including Medford, and Saugus, and it was estimated that 1000 acres were in this condition in the Middlesex Fells Park Reservation and that approximately 3,000 acres were infested in the strip of territory above mentioned.

As summer treatment such as burlap and spraying work has to be done

while the insect is in the caterpillar stage, it was impossible to treat all the areas in the time available.

The residential areas were in good condition and substantial progress had been made. One isolated infestation in Boston was found and promptly treated.

A woodland area in Woburn was discovered which was heavily infested and it was necessary to cut the trees on about 10 acres and burn the brush and ground litter and treat the surrounding growth. (Plates VIII and VIIIa)

Approximately one-half of the field force was discharged in September 1895 in order to give steady employment for the balance of the year to the remaining men.

For several years most of the experimental work had been carried on in the office or storehouse at Malden, Massachusetts, but these facilities were unsatisfactory for certain types of experiments. Early in 1895 land was leased in a forested area in the outskirts of Malden and a building was erected. It had a main laboratory with tables and closets, a private laboratory and chemical room on the first floor and the second floor contained space for use of laboratory employees. It had a small greenhouse on the south side and a covered shed on the north. This made it possible to handle experimental work more effectively. (Plate IX)

Mr. A. H. Kirkland, a graduate in entomology of the Massachusetts Agricultural College, was appointed Assistant Entomologist and was placed in charge of the experimental work under the direction of Professor C. H. Fernald. Mr. H. L. Frost assisted Mr. Kirkland.

The annual meeting of the American Association of Economic Entomologists was held in Springfield, Massachusetts, August 28, 1895. The president's address was delivered by Professor C. H. Fernald and a general discussion on the gypsy moth problem followed. Professor C. V. Riley in closing the discussion stated, "If I were asked to express an opinion, I should not know what to advise further than what the committee is doing. I think it is doing all that can be done."

Dr. L. O. Howard, Entomologist to the United States Department of Agriculture, proposed the following resolution which was unanimously passed:

"Resolved that it is the sense of this Association that the present Gypsy Moth Committee is performing its work in a most intelligent and praiseworthy manner and that its hands should be upheld by the State authorities."

The National F$_a$rmers Congress, which convened at Atlanta, Georgia, October 10 to 16, 1895, passed the following resolution:

"Resolved, that the Farmers' Congress memorialize the Congress of the United States for aid in protecting the country against the

ravages of the gypsy moth, which has so far been held in check by the efforts of a single state."

The National Grange, at its annual meeting at Worcester, Massachusetts, November 13 to 21, passed a similar resolution.

The following quotation is taken from the annual report for 1895 of Professor C. H. Fernald, the Entomologist of the comittee:

"Several entomologists from other States have visited Malden during the season for the purpose of inspecting the work of destroying the gypsy moth, and have expressed themselves as being greatly pleased with the field work and also the experimental work at the insectary. I have been asked frequently during the past season whether we shall be able to exterminate the gypsy moth, and have been obliged to reply that it depends entirely upon whether the Legislature makes sufficient appropriations; and with that body lies the entire responsibility. The cutting down of the appropriations the past three years and the late time at which these appropriations were made has proved most disastrous to the work; and if future Legislatures continue this policy, the insect will neither be exterminated nor will it be held in check, but it will escape and spread over the entire Commonwealth and country.

"There are those who claim that the State should not appropriate money for the extermination of this insect, but that it should be left to land owners to protect their own property from the ravages

of the gypsy moth. This would prove to be the worst possible policy, for the reason that it would be so enormously expensive for land owners, as compared with the expense when carried on by the State."

1896

Early in January the Board of Agriculture requested an appropriation of $200,000 for the year and on January 28, 1896 and on February 7 hearings before the Joint Standing Committee on Agriculture were held and several individuals who opposed the appropriation were heard. They included men who had consistently opposed the work, one of whom was a discharged employee. The reasons for the amount requested were explained by Mr. Sessions, the Secretary of the Board, and by Mr. Forbush, the Director of field work.

On February 25 the hearing was continued and a petition was presented signed by twenty prominent and influential citizens of Boston and vicinity representing that extermination of the insect was impossible, that the appropriation asked for was unwise and suggesting that not to exceed $50,000 be appropriated to keep up the organization and to conduct work in localities most infested and in the main avenues of distribution. Mr. Richard M. Saltonstall acted as counsel for the petitioners and one petitioner appeared in favor of the petition. Evidence was presented to show that the introduction of parasites, the quarantine of the infested territory and treatment of bad infestations would be sufficient and could be accomplished with the funds suggested. Three witnesses not connected with the

gypsy moth work appeared and stated they believed in extermination and that the full amount requested by the Board of Agriculture should be granted, and a letter from Dr. L. O. Howard was read stating that he approved the extermination work.

Experts of the Board testified that the work proposed could not be done with the small appropriation indicated by the petitioners and a petition signed by seventeen officials or citizens of infested cities and towns surrounding Boston was presented in favor of the full amount. The Secretary of the Board of Agriculture stated definitely that if the appropriation was reduced to $50,000 that the work should be placed in other hands.

The available funds were nearly exhausted in March and most of the men were discharged. On April 28 an emergency appropriation of $10,000 was made. This was exhausted before an additional appropriation of $90,000 became available on June 4.

On June 9, 1896, Professor Fernald submitted his resignation as Entomologist to the committee on account of increasing official duties which he had at the Agricultural College. He was urged by the Board to withdraw his resignation which he finally consented to do with the understanding that he could have more assistance on the experimental work and that it would not be necessary for him to spend so much time at conferences and on field trips.

The delay in making funds available made it impossible to

treat many egg clusters and before the spraying work could be organized in June the caterpillars were well grown. As much burlap as possible was applied and the work was concentrated largely in the outer sparsely infested part of the territory. As the towns in the central section of the area had been treated during the previous year, little work could be done in the woodland during the caterpillar season, and some complete stripping resulted. Two isolated colonies were found in Brookline. It was evident that they had been established several years.

As much spraying as possible was done with the equipment available, using freshly percipitated arsenate of lead at the rate of 20 pounds to 150 gallons of water. Most of this work was confined to infestations in Middlesex Falls. Excellent results were secured. As a result of the work done during the year it was possible to determine that approximately two-thirds of the area on the outside of the centrally infested section was only slightly infested, while in the balance of the area the infestation was heavier, particularly in the woodland. Some serious infestations have developed in Middlesex Falls and these were particularly dangerous because of the construction of a considerable number of additional roads for pleasure vehicles. A few electric lines had been built to or through the reservation.

The question of handling forest infestations had become of considerable importance. In the colony in Woburn two tracts of woodland of about an acre each were partially to completely defoliated

and the infestation was scattered over about fifteen acres. The trees growing on about ten acres which included the defoliated areas were cut and, together with the brush, were burned to the ground. The surrounding area was cut and the wood marketed. Most of the woodland known to be infested was on water-sheds or private property, so complete cutting and burning of portions of these areas which were generally infested was not advisable. Removal of the least important trees was followed by spraying or the use of burlap and this treatment proved satisfactory.

During the past six years an increasing amount of cooperation had been secured in treating gypsy moth infestations by the owners of residents. This was particularly true in the cases of many individuals who owned relatively large areas of woodland which they valued highly on account of the beauty of the trees and, in some cases, for their value to the estates concerned. The work of the committee was facilitated as a result of this cooperation. A considerable study was made during the year and for some years previously on the feeding habits of native insectivorous birds, and a list of species was prepared of birds within the infested area which destroy the eggs or caterpillars of the moth. While, as a rule, birds prefer smooth-skinned rather than hairy caterpillars, the fact that they have been found feeding on the moth in any of its stages, is helpful in reducing its numbers.

The effort which had been made to exterminate the gypsy moth in

Massachusetts had attracted considerable attention of the economic entomologists throughout the United States and at their annual meeting held at Buffalo, August 22, 1896, the following resolutions were presented by Dr. John B. Smith, Professor of Entomology, Rutgers College, and Entomologist to the New Jersey State Agricultural College Experiment Station, and were unanimously adopted:

"Resolved, That in the opinion of this association the work done by the gypsy moth committee in Massachusetts is of the utmost importance and value, not only to theState but to all the surrounding States and to the country at large.

"Resolved, That in our opinion the cessation of the work of that committee would be a national misfortune, and a failure on the part of theState of Massachusetts to continue it would be a calamity which would involve immense loss to the people of that State and of the entire country.

"Resolved, That we have full confidence in the ability of the officers now in charge of the commission, as evidenced by the report recently issued, which contains not only matter of extreme importance to the economic entomologist, but of the highest value to the farmer and fruit grower."

On November 10, 11 and 12 this matter was considered at the annual meeting of the National Farmers' Congress and a resolution was adopted as follows:

"Resolved, That the Farmers' National Congress views with alarm the ravages made by the gypsy moth upon the tress and foliage in the New England States, * and petitions the Congress of the United States to cause an investigation of the subject to be made, and to take such measures for the extermination of the pest as may seem wise, as its spread over the country would prove a national calamity."

(*This is an error as the gypsy moth in this country was confined at that time to a small area in eastern Massachusetts.)

A portion of the annual report of Professor C. H. Fernald, entomologist to the committee, follows:

"While the gypsy moth has not spread over the state at large, all reports to the contrary notwithstanding, it has, nevertheless, become so thoroughly established in its present definitely bounded district in the eastern part of the Commonwealth that it will be no slight task to exterminate it or even hold it in check. The state can adopt one of three courses: -

First. It can continue the policy of extermination, which would require large appropriations for a term of years.

Second. It can change the law, which now requires the committee to work for extermination, and adopt the policy of holding the insect in check. This would require a perpetual annual appropriation.

Third. It can abandon the work entirely. This would leave it for the cities, towns and individuals to deal with the pest."

Professor Fernald proposed that if the first course were to be adopted it would require appropriations of not less than $200,000 each year for five years, then at least $100,000 each year for a second term of five years, to be followed by annual appropriations of about $15,000 for perhaps five years as a menas of inspecting and checking upon the territory to be sure no infestations were overlooked. This would cost the State an average of only $105,000 a year for fifteen years which he figured would amount to a tax of only $3.25 on property valued at $5,000 which was about the average value of farms in Massachusetts at that time.

The second course, Professor Fernald stated, would cost about $50,000 annually and indefinitely, which in taxes over forty years would cost $4.24 for each $5,000 property.

The third course, abandonment of the work by the state entirely, would result in spread of the gypsy moth not only throughout Massachusetts but over the entire country. This, Professor Fernald believed, would cost Massachusetts at least $1,000,000 in damage to crops alone without estimate of loss to ornamental trees and shrubs or the cost of sprayinging. The report concluded that obviously a policy of extermination, with funds as recommended, was the wisest and most economical. (Plates X and Xa)

An appendix to the report of the entomologist includes two papers on native predacious insects which attack the gypsy moth, one by A. H. Kirkland and another by A. F. Burgess.

During the last part of the year 1896 the publication entitled "The Gypsy Moth" by Forbush and Fernald was published. It gives a very complete report on the insect both in American and in Europe and other countries, covering the subject in great detail. It was widely distributed to libraries and the scientific men throughout America and many foreign countries and received much favorable comment. It is probably the most detailed publication of any introducted insect pest and covers 495 pages including a bibliography of 10 pages and profusely illustrated with 35 figures and 66 plates including several in color. This work details an enormous effort to record the previous knowledge on the gypsy moth together with many results of research which make it invaluable and a monument to its authors.

1897

In January 1897 a careful inspection of the work was made under the auspices of the Massachusetts Society for Promoting Agriculture by Professor John B. Smith, Entomologist to the New Jersey Agricultural Experiment Station. We are unable to find a printed copy but his report was reviewed by the Boston Transcript in an article quoted below, entitled "<u>It Can Be Exterminated</u>" under the date of February 18, 1897.

" 'I am free to say that I consider extermination possible,' is the statement returned by Professor John B. Smith, entomologist, after

carefully investigating in person the work of the gypsy moth fighters in this State. This is indeed an interesting statement at this time when there is apparently a disposition in the Legislature to cut the sum asked for by the Board of Agriculture for this work. Professor Smith is connected with Rutgers College and with the Agricultural Experiment Station in NewJersey, and his experience in studying the results of importing parasites into California for the destruction of the scale insect, and his wide reputation as an economic entomologist, led the Massachusetts Society for Promoting Agriculture to retain him as a professional adivser in this matter which is of great momentum to this State and to the country at large. His examination was made last month, the better part of a week being devoted to a thorough study of what had been done in past years, using the published reports of the board, and personally travelling over the entire infested area and critically examining the work in progress and the results of past work. The result of this exhaustive and impartial inquiry has just been received by the society above named, and it is in the hands of the Legislative committee having the subject of the appropriation under consideration. It comes before the public here for the first time, but in a necessarily abridged form, as the original would occupy fully five columns of type.

"Professor Smith was started on his mission with these inquiries from the society: 'Is absolute extermination of the gypsy moth possible in Massachusetts and the United States, and if so, is any modification of the present mode of attack desirable? Also, if absolute extermination is impossible, what methods should be employed to keep the insect

under control, and what annual appropriation would be necessary to keep it in control? Is there any possibility of importing parasites of the gypsy moth from its home in Europe to keep it in check here, and what must be done to secure such parasites? Assuming that Massachusetts abandons the work of extermination, what legislation would be necessary to compel the residents of the districts in which the insect occurs to keep it in check?' Professor Smith says that before coming here on this work he had little faith in the extermination theory. He had previously, in 1893, in company with five other entomologists, made a partial examination of the methods employed in this fight. Theoretically, he could not see how extermination would be possible, but since his recent exhaustive examination he believes that if the work is followed out as planned, the pest can be conquered. In the areas which had not been worked on during the winter, the trees were frequently found covered from base to tip with egg clusters, but on the areas where the men had been at work he could not find a single egg mass that had not been treated. In Swampscott, once one of the worst infested territories, it is claimed that for two years not an insect of this species had been found. It is stamped out there at least. Professor Smith, after a minute examination of much of this ground, was unable to contradict this statement.

"Professor Smith approves of the work from the forestry standpoint also, inasmuch as the territory worked over is cleared of its brush, dead trees and all badly infested trees, thus giving the remaining growth a better chance for development. He commends the directors for their painstaking and scientific treatment of all trees that are

trimmed, thus preventing the decay and mutilation which would result from inexperienced work of this description. In speaking of the method of spraying the young caterpillars with arsenate of lead, Professor Smith says that he considers that the entire sum thus far paid by the State for the work of extermination would have been well spent if nothing had been accomplished beyond this discovery by the scientific staff of the committee. While it kills the caterpillars, it does not injure the most sensitive plant. This was practically the only method of attack which was possible in Franklin Park, and so far as subsequent examination has shown, it was entirely effectual. He also approves the burlapping method of capturing caterpillars. He says on this point that 'there can be no doubt that if the trees themselves are carefully treated, so as to afford no hiding-places (That is, if all cavities in the trunks and branches are sealed up, which is the practice), that the burlapping method will result in the capture of practically all the caterpillars on a given tree in the course of the season.' The habit of caterpillars, proved by careful watching of marked specimens by the scientific staff, of returning to the same hiding-place day after day, makes it unnecessary to examine these burlaps daily, once a week being just as effectual.

"Professor Smith goes into all these methods with much detail in his report, for the purpose of showing that every stage of the battle has been carefully considered and mapped out by the committee in charge, and that thorough measures have been provided to cover every possible point. One most important factor in this fight is pointed out in the inability of the female moth to make any sustained flight. She is

heavy and clumsily built, and if she essays flight, she straightway comes to the ground in a diagonal line from any high point she may have started from. This prevents the insect from spreading to any great distance during the moth stage. Another point in favor of the attacking party is that all the eggs are placed together at one point, and are so colored as to be preceptible to the untrained eye forty feet from the ground. Professor Smith states that his sight is decidedly less than normal, and yet on a bright day he was able to see a single cluster at this height. The habit of the inspectors of the committee of walking round a tree on the ground and looking up into its top has been the subject of much public ridicule, and this statement of Professor Smith's will brush away one of the chief hobbies of the superficial opponents of the whole gypsy moth war. Added to these facts the habit of the caterpillars of returning day after day to the same hiding place, makes the work of extermination possible by the methods used, where with other insects they would utterly fail. He is thus brought to the conclusion that the moth can be exterminated, but he takes pains to add 'provided that the committee is enabled to carry on its campaign as mapped out, and is not hampered by an insufficient supply of funds, or by being deprived of money altogether at some critical period during the year.' The second part of the first inquiry made of him he answers by saying that he does not deem it advisable to modify the present mode of attack, as he believes that the field and scientific staff of the committee, with its years of experience, is entirely able to deal with this insect in the most satisfactory way, and that the plan of campaign as outlined is as good as any that can be devised. 'Nothing occurs to me, certainly, that I could suggest

as a modification,' he says. 'It would cost $50,000 a year to keep the infested and suspected territory under thorough surveillance, and in order to check its spread, it would be necessary to have a force of men constantly at work in large colonies, simply to reduce the numbers of the insect. It would mean an annual appropriation of a considerable sum, with absolutely no permanent resulting advantage.'

"Professor Smith then points out that while the insect cannot spread rapidly by its own powers, there is the greatest danger of its being carried by the agency of the trolley lines which traverse the infested area in every direction. Every colony planted outside of the present area of infestation will make it more difficult, more expensive and more impossible to get rid of the insect. He then says that 'if the Legislature does not appropriate a sufficient sum to work for extermination it will be better to abandon the matter altogether. Ido not consider it possible to expend any limited sum of money, as for instance $50,000, to any advantage. There would be no end to this kind of appropriation, and sooner or later the insects would escape, and then all the money theretofore expended will have been absolutely wasted.'

"Continuing on this subject he says: 'My conviction is that for two years to come the committee should be given the full amount asked for, that is, $200,000, and that it should be authorized and required by law to spend not less than $5000 of this per annum in investigating the subject of foreign parasites of the foreign insect. At the end of two years, having given the committee the full sum of money which it

claims it is necessary to expend, it should be in a position to show such definite results in the direction of extermination as to prove positively to all who may make an investigation of the subject, not only that it is a feasible matter, but that it has actually been accomplished in a very large part of the district now under suspicion. If it is unable to make this showing at the end of the two years, it will then at least be in a position to bring in the results of the European investigations, and to introduce parasites in sufficient numbers to make it possible for them to constitute a real check upon the spread of the gypsy moth. If the work of destruction or attempted extermination be stopped at the present time, and the matter of studying and obtaining foreign parasites be only continued, the insect would spread before the parasites were introduced to such an extent that not for ten years thereafter could they, under the most favorable circumstances, obtain control of the moth and the damage that might be caused would be far in excess of the sum of money which the committee ask for.'

"As to his opinion of the destructive powers of this insect he quotes from his work on 'Economic Entomology' as follows: 'It is, perhaps, the most dangerous pest ever introduced into the United States, and should the State of Massachusetts abandon its campaign against it the annual charge upon the farmers of the country would be enormous, if not ruinous.' To this he adds in the report that it is admitted that confierous trees cannot stand being defoliated more than twice, and that defoliation even once would result in the death of most of the pines, and twice of every evergreen tree. Defoliation for

several years in succession would result in the death of all trees. He calls attention to the tremendous loss which would result to the State if the trees in the public reservations were allowed to be killed in this manner.

"The rest of the report is taken up with answering the question as to what legislation should be resorted to to compel the residents of the infested districts to keep this and other insect pests in check in case the State abandons the work. He cites the experience of California and New Jersey in this line, giving abstracts of these laws, and adds that similar legislation is proposed in Illinois and in some other States. He commends these laws, which are based, as he shows, on the old common law principle that no man has the right to use his property in such a way as to injure his neighbor. They are intended to correct the manifest injustice of allowing one man so to neglect his orchards, for instance, that they become the breeding places of insects which will damage the trees of his neighbor, who honestly does all he can to control the pests. He does not, however, recommend that ~~the~~ any such legislation should replace the present effort to exterminate the gypsy moth. To substitute enforced individual effort against this insect, he says, would at the present time result in the unchecked spread of the species. 'I do not under ordinary circumstances favor Government action for private benefits, but here the circumstances are so unusual that extraordinary measures are justified. The State has already spenttoo much money to abandon the matter, when an additional appropriation will probably result in securing the end aimed at.' "

This report speaks in the highest terms of the work of the committee and definitely supports the opinion that extermination of the insect is possible if sufficient means are provided and while the committee expressed doubt as to whether the results of an investigation of parasites is necessary at this time they indicate their readiness to carry through this idea if funds are provided by the Legislature.

As a result of a resolution passed by Congress, Dr. L. O. Howard, Entomologist of the United States Department of Agriculture, investigated the work with the assistance of Dr. C. L. Marlatt during the summer of 1897. His review of the work since it was established with his comments and conclusions have been published in Bulletin No. 11, New Series, Division of Entomology of that Department. This bulletin covers the work and the methods used in considerable detail and reviews some of the objections raised to the project. He indicates that they do not seem warranted as they result only in delaying the availability and reducing the funds which are needed and make it impossible to complete the plan of work effectively and economically. He began his investigation in April and visited the infested area in May, September and finally in November in order to see the different types of work that were being done and evaluate the progress that was being made. His report contains a review of the conditions as he found them compared with those that existed in 1890 and heartily congratulated the State of Massachusetts on the manner in which the work has been carried on, indicating that it will rank as one of the great experiments in economic entomology in the history of the world. He reported that the work was well organized, wisely planned, effectively done and that the insect

had unquestionably been exterminated from wide stretches of territory many of which were most difficult to handle and that on this basis the same results can be secured over the rest of the territory if sufficient means are available.

In view of the importance of problems relating to the suppression of insect pests and plant diseases and the widespread discussion of Horticultural Society to horticultural and agricultural socities, state experiment stations and kindred institutions and organizations to send delegates to a national convention to be held in Washington, D. C., March 5, 1897, to consider the best measures to be taken in securing national legislation and supplementary uniform state legislation to prevent the dissemination of noxious insects and fungi and prevent their introduction into the United States from other countries. This convention was addressed by Dr. B. T. Galloway and Dr. L. O. Howard and other papers were read and discussions participated in by about fifty delegates representing all sections of the United States. 3/

3/ See Proceedings of the National Convention for the Suppression of Insect Pests and Plant Diseases by Legislation, held at Washington, D. C. March 5 and 6, 1897, published by the United States Department of Agriculture.

Among the resolutions adopted was the following relative to the extermination of the gypsy moth:

"Whereas the State of Massachusetts has for the past six years been engaged in an effort to exterminate the Ocneria dispar, or gypsy

moth, an important insect pest, which is as yet confined to a small area in the State of Massachusetts, and which preys upon the foliage of all deciduous and coniferous trees and shrubs, as well as upon the leaves of almost all vegetables and flowering plants, and which if not exterminated will spread all over this country; and

"Whereas the State of Massachusetts has appropriated seven hundred and seventy thousand dollars, of which more than four-fifths has already been expended in the work of extermination with considerable success:

"Resolved, That this is a question of national importance, and that the National Government should assume the work of extermination or render substantial financial assistance to the State of Massachusetts for that purpose, that the work may be carried to a successful conclusion and this continent be thus saved from the ravages of another terrible insect pest.

"Resolved, That the committee on legislation is hereby directed to appear before the proper committees of Congress and advocate suitable legislation to carry into effect these resolutions ."

Resolutions were adopted by the National Farmers Congress at meetings held at St Paul, August 31 to September 1, 1897, approving the efforts of the Commonwealth of Massachusetts to exterminate the gypsy moth and appealing to the Congress of the United States to aid in this project.

The following resolution was also adopted at a meeting of the Association of Economic Entomologists held at Detroit, August 12 and 13, 1897:

"Whereas, The Association ofEconomic Entomologists is familiar with the efforts being made by the State of Massachusetts to exterminate the gypsy moth; and

"Whereas, On two former occasions it has endorsed this undertaking by public resolutions; and

"Whereas, The existence of the gypsy moth in Massachusetts is a standing menace, not only to the agricultural and forestry interests of that State but to those of the country at large; therefore, be it

"Resolved, That this association would urge upon the people of Maxsachusetts the danger of dilatory measures, and the wisdom and great importance of providing liberally for the work of exterminating the gypsy moth."

The Committee on Gypsy Moth, Insects and Birds requested an appropriation of $200,000 for the calendar year 1897 and $150,000 was appropriated on February 27. This was a reduction of twenty-five per cent of the amount requested but prompt action by the Legislature made it possible to continue the field work without serious interruption during the first part of the calendar year. As a result of this it was possible to carry on sonsiderable spraying although this work was

curtailed on account of an unusual amount of rain and unsuitable weather for applying poison. More work was done than usual in infested areas in woodlands and only one badly infested woodland area had to be left without treatment. A considerable portion of the infested area in woodland consisted of part reservations or land that was intended for park purposes in the future. Some of the intensive measures used in destroying moths cannot be applied advantageously in such areas and the work has to be done by using a combination of methods which increases the expense. The treatment of infested stone walls in some cases requires the tearing down and treatment of the egg clusters and replacing the walls. Tests were conducted that demonstrated that most of these walls can be treated with an oil spray flame. When the small caterpillars are hatching and migrating this destroys the living caterpillars and obviates the expense of rebuilding the walls.

For the year 1898 the committee requested $200,000 which was in line with the estimate made in 1896 to cover the funds required for a long range project. In the report of the entomologist the needs of the work were pointed out as follows:

"Since all the experts who have carefully and fully investigated the matter believe extermination to be possible, and, as previously stated, we have already exterminated numerous colonies, many of them in the most unfavorable places and of considerable extent, there can be no question that what has been done in one place can be done in another, and that the complete extermination of this insect is possible, so that the result is dependent entirely upon the action of the Legislature.

"I have no doubt that the gypsy moth would have been practically exterminated by this time if the Legislature had each year made the full appropriation asked for, and made it available early in the season."

An appendix is published with the report of 1897 covering reports of different phases of the experimental work as follows: "Arsenate of Lead as an Insecticide", by C. H. Fernald; "Arsenate of Lead; its Manufacture and Chemical Composition", By Frederic J. Smith; "Experiments with Insecticides", by A. H. Kirkland and A. F. Burgess; "Danger from the Use of Arsenate of Lead", by A. H. Kirkland; "Digestion in the Larvae of theGypsy Moth", by A. H. Kirkland and F. J. Smith; "Notes on Predaceous Beetles 1897", by A. F. Burgess; "The Species of Podisus occurring in the United States", by A. H. Kirkland.

The Brown-tail Moth

On May 8, 1897 word was sent to the office of the Committee on Gypsy Moth, Insects and Birds that an insect which was thought to be the gypsy moth was defoliating pear trees in Sommerville, Massachusetts. Additional complaints were received from Cambridge and the insect was determined by Mr, Kirkland and Professor Fernald as the brown--tail moth of Europe, an insect which causes heavy defoliation to a large number of species of trees and shrubs. A preliminary examination was made and it was found that the insect occurred also in several surrounding towns so a special message was sent by Governor Wolcott to the Legislature on May 27 calling attention to the establishment of this foreign pest. On June 3 a bill was reported placing the work of inspection for this insect in the hands of the committee and later a bill was passed

which was approved June 11, 1897 placing the responsibility for cleaning up this pest in the hands of the local authorities and providing that after proper notice had been served on the owner or manager of the infested premises he may be fined or imprisoned for failure to take the necessary steps to suppress the pest.

(Chapter 516, Acts of 1897)

AN ACT TO REQUIRE LOCAL AUTHORITIES TO SUPPRESS THE BROWN TAIL MOTH.

Be it enacted, etc, as follows:

Section 1. Whenever the pest known as the brown-tail moth shall be discovered in any city or town of the Commonwealth it shall be the duty of the city or town government to take immediate steps for its extinction and to prevent its spread. If they are in doubt what the pest is, they shall notify the Board of Agriculture, and whenever they are informed by said board that such pest exists within their respective municipalities they shall at once enter the work of its confinement to the infested area and its suppression.

Sect. 2. It shall be the duty of the board of agriculture to cause inspections to be made upon the receipt of notice from local authorities, and also whenever the board has reason to suspect the presence of this pest in any city or town, and to furnish the local authorities an ample supply of printed directions as to the best methods for its confinement and extinction.

Sect. 3. It shall be the duty of the owners and managers of premises infested by this moth to exert themselves persistently to confine

and suppress it, under the direction of local and state authorities, and to promptly report any spread of the pest which they may discover.

Sect. 4. Mayors and aldermen of cities and selectmen of towns who shall neglect or refuse to comply with the requirements of this act shall, on information or complaint of the district attorney or on indictment by the grand jury, and on conviction of such neglect or refusal, be fined ten dollars each for every day of such neglect or refusal after the receipt of due notice from the board of agriculture that their city or town is thus infested.

Sect. 5. The owner or manager of any infested premises who shall, after the receipt of a notice in writing from the mayor and aldermen of his city or from the selectmen of his town, or from the board of agriculture, neglect or refuse to comply with this act, shall upon conviction of such neglect or refusal, before any court of competent jurisdiction, be fined one dollar for every day of such neglect, or confined in jail not more than five days nor less than one day, or suffer both penalties in the discretion of the court.

Sect. 6. This act shall take effect upon its passage. (Approved June 11, 1897)

In order to meet the emergency the executive committee of the Board of Agriculture notified the mayors of Somerville, Cambridge, Malden, Medford and Everett that the insect was present in their cities and urged them to take means to secure its suppression. The Board

also voted to expend not to exceed $150 in examining towns thought to be infested. The result of this examination indicated the insect to be present as follows: infested estates, Somerville 1411, Cambridge 355, Medford 149, Malden 92, Everett 72, Melrose 31, Stoneham 31, Arlington 29, Winchester 21, Woburn 19, Charlestown 7, Belmont 3, Burlington 3, Saugus 2, Revere 1.

The brown-tail moth is widely distributed in the old world, its range extending from England to the Himalaya Mountains and from as far north as Sweden south to Algeria, although its original home is central and southern Europe. The insect is recorded in literature and was mentioned as a crop pest by historians as early as four hundred years ago. Observing naturalists have reported and described its habits many times since Geodart wrote in 1635 of its "singular nature" and "remarkable knowledge and foresight" in preparing winter shelters. Numerous citatations have been made in "The Brown-Tail Moth", by Fernald and Kirkland, published in 1903 by the Massachusetts State Board of Agriculture, of the damage it caused in Europe and the methods used in overcoming its ravages.

The insect has been known as "la commune" or common caterpillar throughout Europe and its life history was well described nearly two hundred years ago by Linnaeus in his "Systema Naturae", Vol. 1, page 502, 1758. Most writers have referred to the necessity for cutting and destroying the winter webs and the care that should be taken to avoid the poisonous effect of contact with the hairs.

Life History of the Brown-Tail Moth

(Plate XI)

The Eggs

The eggs of the brown-tail moth are small and globular and are laid commonly in a cluster on the under side of a leaf, usually during July. The cluster contains from two hundred to four hundred eggs closely packed in a mass about two-thirds of an inch long and about one-quarter of an inch wide, and is covered with brown or reddish-brown hairs from the body of the female.

The Larvae

The eggs begin to hatch about the middle of August and the newly hatched caterpillars from each cluster begin to feed in common on the epidermis of the leaves. After molting once or twice each group starts construction of a winter web by drawing together several leaves, at the branch terminal nearby the hatched egg clusters, with the tenacious silk which they secrete. The web is divided by partitions of silk into small pockets in each of which one or more of the small larvae hibernate during the winter. Mortality of the hibernating caterpillars is small unless temperatures become abnormally low. In the spring as soon as the buds begin to develop the larvae cease their hibernation, leave the web and begin to feed on the bud scales and the green tissue of the small leaflets. As they grow the whole foliage is consumed.

The caterpillars, when first hatched about one-twelfth of an inch long, then in five or six days molt the first time and increase in length to about one-fifth of an inch. The second molt occurs usual-

ly in the fall and sometimes within the winter web. These young larvae are blackish in color, covered with reddish brown-hairs, and the head is jet black. The characteristic coloring of the full grown caterpillar begins to appear at the second spring molt when the larvae are about three-eights of an inch long. When full grown the brown—tail caterpillar is 1½ to 2 inches long and covered with hairs, the head is light brown, the body is dark brown to nearly black, with a broken white stripe laterally, and two conspicuous reddish spots dorsally near the posterior end. The hairs covering the caterpillar consist of two sets from the same tubercles, one set is long and barbed, the other is also barbed but shorter and velvety in appearance. When the short barbed hairs come in contact with human skin they cause a severe irritation known as "The brown-tail itch". The hairs are poisonous as well as irritating. Internal irritation caused by breathing in or swallowing the hairs may result in serious poisoning. The hairs are present not only on the caterpillars but, also, to a less extent on the pupae, the moths, and in the winter webs so that extreme care must be taken to avoid direct contact with the pest in all its life stages. (Plate XXIV)

The Pupae

The caterpillars become full fed the latter part of June and then spin a cocoon, separately or in masses, in leaves at the end of twigs or frequently in crevices of rough bark on tree trunks. These cocoons are spun loosely, usually by drawing leaves together and are seldom compact. The pupa itself is dark brown in color, about five-eights of an inch long, with a concial spine at the end of the abdomen and is

sparsely covered with yellowish-brown hairs. The pupal stage lasts about two weeks.

The Moths

Emergence of the moths begins usually during the first week in July. The female is larger than the male but both sexes are pure white except for the characteristic hairy brown-tufted tip of the abdomen, more conspicuous on the female, which is nearly golbular in form and from which comes the name "Brown-tail moth."

Both male and female fly readily, mainly at night. They are greatly attracted to bright light and may be seen about brilliant streetlights during the flight period which may last as long as three weeks in July.

Feeding Habits

The caterpillars feed mainly during the daytime. The favorite food plants are the leaves of the apple, pear, cherry, oak and willow trees, but they feed on many other common deciduous trees and shrubs in heavy infestations. They do not attack coniferous species.

Control Measures

The easiest and most efficacious means for controlling the brown-tail moth is to collect and destroy the winter webs any time after the leaves have fallen, preferably before the first of April. The twigs carrying the webs are clipped off with tree pruners and the collected webs are destroyed by burning. If trees, particularly fruit trees,

are very heavily infested, care should be taken to remove as little of the wood as possible.

After the leaves come out in the spring it is no longer worth while to collect the webs as the young caterpillars will have then commenced feeding. The only practical remedy at this stage is spraying, with arsenate of lead preferably, and this should be done as soon as there is any foliage to retain the spray. Spraying is somewhat effective if applied, also, at the time the eggs hatch in August but usually should not be resorted to on orchard trees at this time because spray residue on the fruit is undersirable. If web collection in the winter and early spring spraying has been practiced summer spraying seldom will be necessary.

1898

The appropriation requested for gypsy moth work for 1898 was $200,000. The work was continued during January and as no additional funds were appropriated, on February 1 the field force was discharged. An emergency appropriation of $20,000 was made in Febraury and the men were put back to work. As soon as these funds were exhausted the men were again discharged. In April an appropriation of $180,000 in addition to the $20,000 emergency funds was approved so that the men returned to work on April 23. It was too late to do much of the important spring work but burlaps were applied during May and June. Legislation was also passed providing for control operations on the browntail moth under the direction of the Committee on the Gypsy Moth, Insects and Birds of the Department of Agriculture, and $10,000 of the gypsy moth appropriation was segregated for this purpose.

April 25, 1898 war was declared by the United States against Spain and continued throughout the summer. The Treaty of Peace was signed December 10 of that year. Owing to the short duration of the war the serious hardships as we know them today and regulation of purchase and sale of materials were not necessary, although the public was in a very excited state of mind until the peace was declared and this affected to a considerable extent all kinds of civilian activities.

On March 24, 1898, the House of Representatives of the Massachusetts Legislature passed a resolution memorializing Congress to grant an early and liberal appropriation to assist in the extermination of the gypsy moth in Massachusetts and calling attention to the investigation of the work made in 1897 by Dr. L. O. Howard, Entomologist of the United States Department of Agriculture which had been authorized by Congress and which indicated that progress was being made and that appropriations for the work should be continued. It also called attention of resolutions passed the previous year by the Association of Economic Entomologists, which has in its membership practically all of the economic entomologists of the United States, supporting the work, and the resolution by the F$_a$rmers' National Congress appealing for Government funds to assist the State of Massachusetts in this undertaking. No favorable action was taken by Congress, however, as the result of this memorial.

In the fall Dr. Howard again visited the infested area and reported that he was convinced of the soundness of the recommendations

which he published in Bulletin No. 11 and which was issued as the result of his intensive examination of the conditions in the infested area during the previous year.

In August the annual meeting of the Association of Economic Entomologists was held in Boston and an opportunity was given the members present to visit the infested territory and inspect the work that was being done. The following resolution was passed by the Association:

"Resolved, That, the work of the gypsy moth committee in the State of Massachusetts having been inspected in all its details by a large number of the members of this association, and its methods of operation observed, it is our opinion that too much praise cannot be bestowed upon those who are carrying out this important work. We consider that they have adopted the best methods yet devised for controlling the spread and ultimately exterminating this destructive insect; that their work, on the whole, has been remarkably successful, when the extensive area to be gone over and the insufficient or retarded appropriations are considered; and that there is every prospect of the accomplishment of the object of the committee,--the absolute extermination of the insect in the State of Massachusetts,--provided the funds sufficient for the purpose are placed at their disposal.

"We consider that a stoppage of their work, or any serious reduction of it, would involve not only the loss of all that has been

already accomplished, but would also permit this destructive insect to ravage the State and eventually spread over a large part of the Union, and cause an inclculable amount of injury to the whole community.

"We trust the Commonwealth of Massachusetts will continue to make early and ample provision for carrying on this work in a thorough manner for a few years longer, when we expect that the insect will have been brought under such control that a more limited expenditure will be sufficient."

"We trust the Commonwealth of Massachusetts will continue to make early and ample provision for carrying on this work in a thorough manner for a few years longer, when we expect that the insect will have been brought under such control that a more limited expenditure will be sufficient.

The address of the president of the Association, Professor Herbert Osborn, head of the Department of Entomology at Ohio State University, Columbus, Ohio, made the following comments relative to the gypsy moth work:

"The heroic effort made by this State of Massachusetts to exterminate the gypsy moth is one of the best and most effective arguments for a system of exclusion, the cost of which would be slight compared with the loss entailed by an imported pest. This gigantic effort is but partially understood or appreciated even by entomolo-

already [illegible], but [illegible] [illegible] [illegible]
to [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible], [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]
[illegible].

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

gists and I count it one of the great opportunities of this meeting that we may each see for himself the methods employed and results obtained in this undertaking, the equal of which is not to be found recorded in history.

"Dr. Howard gives most emphatic testimony as to the propriety of undertaking suppression, and also that the money appropriated for the purpose has been used in the best possible known method to accomplish the desired result. I beg to suggest in this connection that when we may have secured a general consensus of opinion on such questions, we should each strive to give individual support to it. By raising objections we tend to obstruct our science, and unless some vital principle is at stake, we may far better not permit such division of opinion to go before the public. Diversity of view is one of the essentials of progress, but let us have expression of such diversity among ourselves, and so far as possible stand together in final recommendations to the public.

"There crops out at times an indication of a sad lack of appreciation on the part of scientific men of the aims and results of economic work. That a reputable scientific journal should consent to such a slur upon the work of the Gypsy-moth Commission in Massachusetts as has recently appeared, shows either unfortunate jealousy or unreasonable prejudice against such effort. When the highest available authority has been definitely committed to a certain policy, there is certainly every reason why men of science in related lines should avoid such criticisms or contemptuous sneers as to prejudice a uninformed public against such policy. The general public is at best slow to adopt the

results of science and inclined to be suspicious regarding even well-established points. What else can we expect, then, if some parties in the name of science denounce such results but that scientific work in general shall be discredited and its advancement hampered where it should be supported."

After reviewing the work on the gypsy moth and the failure of the Legislature to promptly appropriate the full amount requested, Professor C. H. Fernald, entomologist of the committee, made the following comment:

"I feel very strongly that it is time for the Legislature to settle the question whether the State is to work for the extermination of this pest,or not. If this is not to be done, then no further appropriations should be made; but, if it is to go on, what valid reason can any candid person give why the undivided opinion of all economic entomologists in America, who are the only experts in a case like this, should not be accepted, and the amounts estimated by those who are best informed and have given the closest study to every detail of the work be appropriated?"

An appendix to the annual report contains papers entitled "Improvements in Spraying Machinery" by E. H. Forbush; "An Egg-Eating Beetle" by A. F. Burgess; "On the Value of Glucose in Spraying" by A. H. Kirkland.

It should be mentioned that it is the custom when improvements in

equipment or the results of experimental work develop better methods to immediately change the field procedure so as to bring about more effective results. The same rule is followed relative to discontinuance of methods determined by tests to be of doubtful value. This has resulted in improved spraying equipment being secured and the use of glucose as a sticker for arsenate of lead being discontinued.

The Brown-Tail Moth

Relative to this insect Professor Fernald reported:

"This insect should be considered entirely by itself, and not grouped with the gypsy moth, if the question of its extermination is to be considered; for the reason that its habits are so totally unlike those of the gypsy moth that there is little or no economy in attempting to wage war against both insects at the same time. The action taken by the Legislature thus far would lead one to the conclusion that before a majority of our legislators can be convinced that this is so serious a pest that it should be dealt with by the State, it will have spread so far and wide over the country, if it has not already done so, that extermination will be impossible.

"Fearing some such outcome as this, the committee have instructed the field director and entomologist, with such assistants as they may need, 'to collect such information, both in this country and in Europe, in regard to the brown-tail moth, and make such experiments with the insect as may be useful to the committee in future dealing with the creature and necessary for the proper enlightenment of the

public on the subject, with a view to publishing the said information if it may appear desirable.' "

1899

The State law of Massachusetts empowered different state departments to continue expenditures during the month of January "until the pleasure of the General Court is made known, at the rate of expenditure authorized by the apporpriations of the preceding year." This made it possible to continue the gypsy moth work until February 1, 1899, as the proportionate amount of funds for the preceding year was available for use. Nevertheless, it was necessary on February 1 to discontinue the field operations until an emergency appropriation of $30,000 became available February 15. Due to the very heavy snowstorms on February 12 and 13 it was impossible to resume work until February 22. On February 5 a bill was introduced in the House of Representatives to repeal the law relative to gypsy moth which was enacted in 1891. This bill was not enacted into law. The history of the previous year was repeated and the amount appropriated, $170,000 did not become available until April 15 so that more than a month of valuable working time was lost which could have utilized to great advantage to the work.

"The unfortunate interruptions of the work in the spring months had two equally undersirable results: (1) The clearing up of large areas of infested woodlands, a preparatory measure absolutely essential to the effective treatment of those regions, was perforce neglected until nearly the hatching time of the eggs, after which the

measure was impracticable. (2) With the spring demand for labor, a number of our skilled employees, men whose experience made them especially valuable to the work, had sought and obtained other and more permanent situations, and their services were thus lost to the Board."

Where woodlands are infested it is of prime importance to destroy the egg clusters in the fall, winter and spring. The economy of this practice is well understood.

Constant turnover in man power due to discontinuance of the work for more or less extended periods makes necessary the corresponding replacements of untrained personnel and increases operating costs.

Additional burlaps were applied in June and early July and these together with a large number that remained on the trees during the winter amounting in all to about 3,000,000 were examined and the caterpillars and pupae killed up to the time that the moths emerged in late July.

The season was favorable for spraying and 20 outfits were operated in the field. In some localities where spraying was applied early its effectiveness was reduced somewhat as the result of seasonal rain. At the close of the burlap season the force of men was reduced to 200.

The discouraging developments of the season were the finding of colonies adjoining the known infested area in Newton and Georgetown. Vigorous clean up operations were carried on in both these areas.

At the annual meeting of the Association of Economic Entomologists held at Columbus, Ohio, August 19 and 20, 1899, the presidential address was delivered by Dr. C. L. Marlatt, A sistant Entomologist of the United States Department of Agriculture. He took for his title "The Laisser Faire Philosophy Applied to the Insect Problem". In treating the subject in a broad way he indicated that natural factors determine the abundance or scarcity of plant and animal populations and in the long run maintain a balance over extensive regions throughout the world. He questioned the value of extensive control and quarantine operations as he believed in the long run natural elements would take care of the situation. While ad mitting that chronic conditions exist where intensive treatment might be valuable he believed that the relatively small amount of work that could be done by man had little effect on the control of pests but that animal parasites, predators, unfavorable growing conditions, climate, and many other factors, some of which could not be definitely determined or measured, exercised in the long run reasonable control. He admitted, however, that there was some point in attempting to maintain national quarantines to prevent the entrance of pests that had not become established in this country and that it was worth while to stamp out or attempt to stamp out introductions of noxious species before they had an opportunity to develop or spread extensively.

This address, as was doubtless the purpose of the president, provoked considerable discussion in which a number of members raised different degrees of criticism. It was pointed out that the term "laissez Faire" would doubtless give the public the idea of a strict-

ly "let alone" policy so far as controlling insects was concerned, but the opinion was expressed that it should be interpreted in a restricted sense. Otherwise, practically all progress that had been made in artifically controlling insect damage would be discouraged. Such efficiency in quarantine measures as was illustrated by the excellent work done by Mr. Alexander Craw at San Francisco might be considered unnecessary and superfluous. The question was also raised as to the depressing effect of emphasizing pessimistic policies which would result in destroying the interest of the public in doing any work at all on any insects or diseases and which would cause the suggestions of economic workers to be ignored or ridiculed while those who had suffered most from negation were waiting for a harmonious and perfect balance of nature to be established.

The position of the Committee of the Massachusetts Board of Agriculture on the Gypsy Moth, Insects and Birds that this insect could be exterminated was supported by the most prominent entomologists as well as many organizations of national and local importance, and because great progress had been made there was considerable concern that a "laissez faire" philosophy might catch the fancy of those who opposed the work and increase the difficulty of attaining the object for which the project was established.

Before adjournment of the Columbus meeting the following resolution was passed:

"Resolved, That the Association as a body endorses and commends

the work of the gypsy moth committee of the State of Massachusetts in continuing the extermination of this pest."

A resolution was also passed by the Farmers' National Congress at its annual meeting supporting the gypsy moth work.

Since June 1895 the writer had served on the gypsy moth work in many capacities, having started at the lowest grade, and had acquired varied experience on the field work, although most of these years were spent as an assistant on many lines of experimental and laboratory work particularly on predaceous beetles and testing insecticides.

In September 1899 an offer was received of a position as assistant in entomology in the University of Illinois to carry on instruction work. At the end of the college year an offer of field assistant on nursery and orchard inspection at the Ohio Agricultural Experiment Station was accepted and two years later after a change in the law placed the work with the Ohio Department of Agriculture he became chief inspector for the State, where he remained until early in 1907. During this period there was little close personal touch with the gypsy moth problem until he returned to Massachusetts in the latter year to carry on work on the gypsy moth.

Owing to continued ill health the director of field work, Mr. E. H. Forbush, was granted a leave of absence for three months dated October 19, 1899. During the eight years in which Mr. Forbush had

had charge of the work he had given to the States services and importance and value of which can hardly be overestimated. The Board of Agriculture placed on record its high appreciation of his worth as a most faithful official. During his absence his duties were discharged by Mr. A. H. Kirkland, assistant entomologist to the committee.

In a letter to the gypsy moth committee, dated October 23, 1899, Dr. Howard wrote as follows: "The condition of the entire territory is admirable; it surpasses my expectations of two years ago, and far surpasses my expectations of the past midsummer, when I learned of the two new outside colonies. The fact is, that the field force, under such experienced field superintendents as you now have, is now able without hesitation to do exactly the right thing in such emergencies as those of the past summer, and to do it promptly and without waste of effort. It has taken all these past years to arrive at such a condition of affairs."

The annual report of the entomologist to the committee, Professor C. H. Fernald, gives substantial information on the problem.

Cost of Extermination

"In my report of January, 1897, to this committee, I gave an estimate of the time and money that would be required to exterminate this insect, which was an appropriation of not less than $200,000 a year for a term of not less than five years, and then an appropriation of not less than $100,000 a year for a term of not less than five years,

after which an appropriation of perhaps $15,000 a year for a period of five years would be required. Wishing to obtain the opinion of Dr. Howard on this estimate, I wrote him, and, in a letter dated February 20, 1899, he writes as follows: "I think your estimate of the time it will take to exterminate the gypsy moth, as published in the reports and bulletins of the gypsy moth committee, is reasonable, and I think that, if the money is appropriated and made promptly available, extermination will be accomplished, as you prophesy.' The Legislature has not given the required appropriations until the last two years. Even then $10,000 each year of the necessary appropriation was required to be spent on the brown-tail moth, and there have also been unfortunate delays in granting these appropriations. Yet, from the results of the last two years, I am more than ever convinced that the insect can be exterminated in the time indicated, if the full amount asked for each year be promptly appropriated.

The Action of the Legislature

"The only uncertainty at the present time about extermination is the action of the Legislature. There are members of this body who have taken time to investigate the gypsy moth work thoroughly. They have gone over the infested territory and studied the problem very carefully from every point of view, with the result that they realize the full gravity of the situation; the great destruction that this insect would cause if allowed to spread over the State; the impossibility of extermination or of successfully dealing with the pest by individuals or even municipalities; and they are also convinced that the State can and ought to furnish the means necessary for the absolute

extermination of this insect. There are others, who, unfortunately, have had neither time nor opportunity to investigate this work, and they may not be familiar with such problems. I am not surprised that such persons should think it impossible to exterminate the moth, for several noted economic entomologists held the same opinion before visiting the infested territory; but after making a careful inspection, they invariably became convinced not only that extermination was possible, but that it was the manifest duty of the State to carry on the work to completion.

"The experience of the past nine years has proven conclusively that when the appropriations are reduced one-third or one-half, as was the case for several years, little or no gain is made towards extermination, and therefore this policy results in an absolute waste of public money. If, therefore, the Legislature will not appropriate the full amount required for the successful prosecution of this work, it would be better to make no appropriation whatever. The best interest of every tax-payer in the Commonwealth of Massachusetts demands that the Legislature shall promptly grant the full appropriation asked for by the gypsy moth committee."

In the part of the annual report which was prepared by Mr. Kirkland, it was indicated that conditions in the infested area had improved greatly during the periods when the full amount of funds required were made promptly, and that in many towns only a minimum amount of work was required to effect complete extermination. In other towns a longer time, with additional checking, after the last trace of the insect had been found would be needed to complete the

job. In a few more, extensive and continuous work would be necessary to exterminate the pest. The need of aggressive and continuous work was urgent and offered the greatest promise to the public who pays the bill. The system of leaving the work to the individual had been tried and failed and in the end those who earnestly attempted to protect their own property had been the most severely penalized. He stated the cost to the individual texpayer had not been excessive and was cheap insurance based on what could be accomplished if the work could be continued in a systematic and thorough manner. Good judgment would seem to have dictated that this course should be pursued.

1900

The work undertaken for the extermination of the gypsy moth in Massachusetts by the Committee on the Gypsy Moth, Insects and Birds of the State Board of Agriculture was under the direction of Mr. E. H. Forbush, Director, and Professor C. H. Fernald, Entomologist, from May 19, 1891 to February 1, 1900 when active field work was discontinued. This was the result of a combination of circumstances. The depredations of the insect had been so greatly reduced at the end of 1899 due to the intensive work that had been done that even slight injury was not easy to find and further large expenditures did not appear to be warranted to some laymen and taxpayers. Because of the attitude of individuals and groups who opposed the work from the beginning and capitalized on the general apathy of citizens in the uninfested sections of the State, clamor from discharged or dissatisfied employees who had some real or imaginary grievances, the cost

of the undertaking on account of relatively small injury being noticeable and the pressure of the immediate introduction of foreign parasites, which the committee did not believe to be advisable while a compaign for extermination was under way, the opposition grew sufficiently to induce the Legislature to appoint a committee to investigate the work.

On January 16, 1900 the House of Representatives passed an order as follows: "Ordered, That a joint special committee, to consist of eight members of the House and such as the Senate may join, be appointed to inquire into the present state of the work of exterminating the gypsy moth. Said committee shall report in writing to this General Court on or before February 15 of the present year upon the practicability of extermination, and make any recommendations which may seem proper in the premises, and shall have power to send for persons and papers."

Concurrence was voted by the Senate on January 19. A committee of three members was selected by the Senate on January 22 and on the following day eight members were selected by the House. Later additional orders were adopted authorizing the committee to travel within the limits of the Commonwealth, to employ a stenographer and extending the time for making the report to March 22. No authority to examine witnesses under oath was provided.

Hearing Before the Joint Special Committee Appointed to Inquire Into the Present State of the Gypsy Moth Work

The first session of the hearing was held on January 30,1900

with Senator L. E. Chamberlain of Plymouth as Chairman.

He indicated that the purpose was to consider - "Is extermination possible or probable? (1) If answer is yes, consider what progress has been made. (2) Are methods efficacious? (3) What will be the probable expense? If extermination is impossible or improbable consider (1) Should present policy be continued? (2) Should we simply suppress outbreaks? (3) Should work be abandoned?

"First, hear the Board of Agriculture.

"Second, give all the opportunity to appear in opposition to the work, make suggestions and give the Board an opportunity to answer. Committee has no desire to curtail anybody."

Questions and statements were permitted by any one regardless of their pertinence to the subject and the testimony rambled far afield.

Seventeen public hearings were held, the first on January 30 and the last on February 26, and 1,537 pages of testimony were taken. These reports and others are in the State library at Boston and have been carefully examined. The committee on three occasions visited the infested district and the sub-committee visited New Hampshire in the discharge of their duties. Individual members of the committee travelled in the district and gave the committee the benefit of information gained from observation and personal interviews. No actual field work could be seen during this period as it had been discontinued due to exhaustion of funds.

The following table shows types of witnesses and their opinions: -

Type of Witness	For	Pages of Testimony	Against	Pages of Testimony	No Opinion	Pages of Testimony
Officials of the Work	10	482	0	-	-	-
Employees	10	88	1	54	-	-
Former Employees	7	111	11	225	3	7
Market Gardeners members Boston Market Gardeners Association	2	8	9	90	-	-
Representatives of Farmers and other farm Associations	2	13	1	4	-	-
Farmers	3	13	1	3	—	—
Property and Estate Owners	5	28	5	73	-	-
Scientists*, not including Professor Fernald	1	25	5	22	-	—
Town officials and interested citizens	25	124	14	112	-	-
Members of the Legislature	1	7	2	18	-	-
Others	-	-	-	-	7	16
Total	66	913	49	601	10	23

* In addition to the testimony of the above witness, questions relative to to the gypsy moth problem were sent to the group of economic entomologists in the United States and Canada, most of whom were recognized as the leading authorities on insect control and extermination.

The special committee made the following comments on answers received from nine of these experts. "These testify generally to their belief in extermination based in nearly every case upon the condition that a sufficient sum of money should at all times be available for use."

Of the 49 witnesses who testifies against the work, 43 expressed the opinion that extermination was not feasible, could not be accomplished, and the policy should be changed. Seventeen of the 49 witnesses charged that politics affected confidence in the management of the work and five of the 49 stated their belief that the spread of the gypsy moth was caused by deliberate planting. Some of the witnesses held all of these views.

Particular emphasis was given, as may be judged by the nearly stereotyped line of questioning, to testimony purporting to show political connivance and mismanagement by Mr. Forbush, and to opinions regarding the impracticability of the extermination policy. The admission of biased and unsupported testimony by former employees and by one of the market gardeners was as remarkable as the questioning tending to discredit testimony of witnesses in favor of the work.

At least four of the former employees, and one then employed, admitted they continued to work on the job after they were convinced it was premeated with politics, and that they remained to secure information detrimental to the work. It was clearly evident that testimony offered

in some cases by these men was wholly unfounded because they were ignorant of and could not have been in a position to know the facts, or because they distorted the facts deliberately. The deliberate distortion offacts without supporting evidence, especially by one market gardener and one estate owner relative to the above complaints, is evident.

When proper weight is given to the opposing testimony, considering the type of men who testified and the personal knowledge they had of the whole work it is evident that the future dangers and expense to the State of Massachusetts as well as to other States and the Federal Covernment were beyond their comprehension.

The report of the special committee was made to the Legislature in March 1900 and covered twenty seven printed pages.

The recommendations and reasons therefor are included and a bill as submitted to make them effective.

"We make the following recommendations:-

1. An abandonment of the theory of extermination and a repeal of the present law.

2. A continuance of the work by the cities and towns interested, with authority to impose such obligations on the citizens as seem proper and reasonable.

3. In place of the plan abandoned, a substitution of the policy of suppression and of preventing the spread of the insect.

4. Such assistance from the Commonwealth, in the form of reimbursement for a portion of the money expended by the municipality, as to the Legislature seems just and fair.

5. The imposition on certain city or town officers of the general charge and oversight of the work in their respective community.

6. A proper safeguarding of the State's interest in the public reservations.

We believe this will result in doing away with a useless and complex army, now too largely officered.

It will abolish the wasteful method of scouting and hunting for work.

It will promote a feeling of responsibility now almost unknown.

It will re-establish an element of common-sense in the treatment of this insect, permitting the citizen to deal with it as he has dealt with other pests, instead of from a highly technical standpoint.

Instead of saying to the individual, Keep your hands off; don't touch the egg; don'ttouch the moth; send for the State, — it will encourage him to kill the insect, not discourage him; it will give him information and teach him how to protect himself. But, as the injury of one is the injury of all, the community should protect itself; and, as the city and town are the creations of the State, the State, always mindful of its own, should render needful assistance when its own larger interests are involved.

It will permit the introduction of business methods, as a substitute for scientific accuracy in book-keeping and field work.

It will save travelling expenses of highly paid officials, by substituting local for outside management.

It will not involve the spending of such large sums for advertising, photography, caps, uniforms, postage, printing, telegraphing and telephoning, and many other items of office supplies will be rendered unnecessary.

It will go into operation with the advantage of well-established methods of work, and save the time and money of costly experimenting.

It will foster and promote local civic pride, so essential to good citizenship.

It will end the temptation incident to such large shares of patronage.

It will permit of the discussion and adjustment on the merits of the question involved, and will not allow it to be used as a vehicle to assist lame and impotent measures to become legislative enactments.

The interests of State, town and citizen are properly protected, and no interests are imperilled. The committee beg leave to submit the accompanying bill."

The report was signed by all members, although three dissented relative to the amount to be expended by the State and the amount to be repaid to the cities and towns.

"COMMONWEALTH OF MASSACHUSETTS"

In the Year One Thousand Nine Hundred

AN ACT

To Provide for the Suppression of the Gypsy Moth.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the authority of the same, as follows:

Section 1. Cities and towns are hereby authorised, empowered and directed to provide and carry into execution all reasonable measures to promote the suppression and to prevent the spreading of the gypsy moth within the Commonwealth, and for that purpose shall raise annually by taxation and appropriate such sums of money as may be deemed necessary, to be expended to cities under the direction of the board or official having the care and control of the shade trees in streets and in towns under the direction of the tree wardens, thereof, except that in cities and towns where provision is made for park commissioners such expenditure as may be made in carrying out the purposes of this act in the parks and open spaces under their control, shall be made under the direction of such park commissioners.

Section 2. All such officials shall have full authority to provide all necessary material and appliances and to employ such servants and agents as they may deem necessary in carrying out the purposes of this act, and such officials in the cities and towns in which they are authorized to act, shall have the right themselves, or by such servants or agents, to enter upon the lands of any person in the execution of the purposes of this act. But no expenditure shall be made or liability incurred by any such official, in excess of the amount appropriated by his city or town for said purposes.

Sect. 3. The owner of any land so entered upon who shall suffer damage by such entry or by acts done thereon by such officials or under their direction, may recover such damage of the city or town in which are situated the lands so claimed to have been damaged, in an action of tort; but any benefits received by such entry and the acts done on such lands in the execution of the purposes of this act shall be determined by the court or jury before whom such action is heard, and the amount thereof shall be applied in reduction of said damages; and one-half of the amount of damages recovered against any city or town shall be refunded by the Commonwealth to such city or town.

Sect. 4. Said officials shall within their respective jurisdictions have full authority to make rules and regulations in furtherance of the purposes of this act, enforced by suitable fines and forfeitures, not exceeding twenty dollars in any case, which rules and regulations shall be published in one or more newspapers, if there be any, in the city or town where such rules and regulations are to take effect, and copies of such rules and regulations shall be posted in at least three public places in such city or town.

Sect. 5. The metropolitan park commission is hereby directed to carry into execution all reasonable measures to promote the suppression and to prevent the spreading of the gypsy moth within the parks and reservations under its control, and for that purpose shall expend such sums of money as may be necessary, and one half of the sums so expended shall be considered a part of the regular expenditure for the care and maintenance of said parks and reservations, and the other half shall be borne and paid by the Commonwealth.

The metropolitan park commission shall make returns of the amount expended by it in carrying out the purposes of this act, in such form as shall be prescribed by the auditor of the Commonwealth.

Sect. 6. Any other board or commission having the care and control of any lands of the Commonwealth other than those in the care and control of the metropolitan park commission, shall carry into execution all reasonable measures to promote the suppression and to prevent the spreading of the gypsy moth in such lands; and the expense thereof shall be borne and paid by the Commonwealth.

Sect. 7. The treasurers of cities and towns shall make return of the amounts expended in carrying out the purposes of this act, in such form as shall be prescribed by the auditor of the Commonwealth, and the Commonwealth shall annually repay to each city and town one half of the amount so expended by such city or town.

Sect. 8. Any person who shall purposely resist or obstruct said officials or any of them, or any persons, servants or agents employed by them under the provisions of this act, while engaged in the execution of the purposes of this act, shall be punished by a fine not exceeding twenty-five dollars for each offence.

Sect. 9. It shall be unlawful for any person knowingly to bring into this Commonwealth the insect known as the gypsy moth, or its nests or eggs, or for any person knowingly to transport said insect, or its nests or eggs, from any town or city to another town or city,

or from place to place within any town or city, in this Commonwealth.

Sect. 10. All property now in the possession of the state board of agriculture and heretofore used by it in the work of exterminating the gypsy moth, shall be sold, at not more than the cost thereof, to the cities and towns making application therefor. And said board of agriculture, through its secretary, shall advise local authorities as to the habits of said moth and the best means to be employed to prevent its spread and to promote its suppression, and shall cause all facts in its possession and all that may hereafter be obtained relative to said moth to be circulated in such manner as said board may consider for the best interest of the Commonwealth.

Sect. 11. For the purpose of carrying out the provisions of this act, so far as expenditures by the Commonwealth may be required, a sum not exceeding forty thousand dollars may be expended.

Sect. 12. Chapter two hundred and ten of the acts of the year eighteen hundred and ninety-one and all acts and parts of acts inconsistent herewith are hereby repealed; but all claims under any of said acts for damages for entry upon and acts done on the lands of any person may be prosecuted and the damages ascertained as provided in said acts; and one half of the amount of damages recovered against any city or town shall be refunded by the Commonwealth to such city or town.

Testimony before the Committees on Ways and Means and Agriculture sitting jointly, April 5, 1900, was given by Mr. William R. Sessions, Secretary of the Massachusetts State Board of Agriculture, and is

taken from the 1900 report of the Committee on the Gypsy Moth, Insects, and Birds, as follows:

"I have been much interested in this report of the investigating committee, and have examined it somewhat critically, and find that we have been condemned for our success in the enterprise. I find on the fourth page of the report that the investigating committee say: 'It has not been clearly demonstrated to the committee that the actual damage done thus far has been of any considerable damage financially.' Why is this? Simply because the gypsy moth committee, in whose charge the work has been, have succeeded in their work,--for which we are condemned. Again, they say: 'There are to-day, so far as known, no large colonies.' Why? Simply because we have succeeded in our work,--for which we are condemned. Again, they say: 'We find no substantial evidence that gardens, crops or woodlands have suffered serious or lasting injury.' The reason for this is the same as given before.

"Again, the committee criticise the Board ofAgriculture, on page 5, and say that, 'the Board has fairly left itself open to adverse criticism in this particular,' i.e., the dissemination of information as to the danger from the depredations of the moth; and say: 'Such methods should not be tolerated.' What is the Board of Agriculture for? What was the duty put upon the Board ofAgriculture by the Legislature in reference to the moth? Has it not been a part of its duty to inform the State as to the necessity for appropriations? How otherwise should the Legislature be able to judge whether the appropriation was necessary, and how much, and who was to give the information, if not those appointed by the State to do the work and care for it?

"The investigating committee say, also, on the same page: 'Continued experiment and study have given us the most approved methods of defense and attack, and to cope with and check its spread is now a matter of comparative ease.' To whom is the credit of this due, if not to the gypsy moth committee? Who has experimented and sought for expert advice of all men in the country who were able to give such expert advice, and taken advantage of it to bring matters to their present condition, if not this committee? And this committee are condemned for their success. Again the investigating committee say, on page 6: 'There are to-day no known colonies in existence and no immediate danger of serious outbreaks.' Yet the committee in charge are condemned, and the investigators say suppression is all that is necessary.

"On the same page the investigating committee criticise those in charge of the work for the number of officials employed, as director, assistant director, superintendents, agents, inspectors, etc. As a member of the committee from the first year, I wish to say that the appointment of these officials was made necessary by the exigencies of the case. Being obliged every year, from the lateness of the appropriations, to employ a large number of new men, having lost many of our best men, it was absolutely necessary to have a sufficient number of skilled and experienced men to instruct the new men. Each appointment, each increase of an official was made deliberately after investigation by the committee. These officials were in part made necessary by the immense amount of territory that had to be attended to. Work in thirty towns in quite different from work in a single shop, even though there may be several rooms in that shop; and to enable those

in charge to know and to keep in closetouch with all that was going on, not one of those officers could be spared.

"Again, the report of the investigating committee says, on page 6: 'When it becomes necessary to suspend field work, owing to the exhaustion of funds, officials are retained, doing privates' work, at no reduction of salary.' That is true, and it is true because the committee believed that to be the most economical plan for the State. These officials, superinetndents, inspectors, etc., are the skilled men of the force,--men of the most experienced, of the greatest reliability; men the most capable, not only of directing the force, but of performing the work; and they were retained for two reasons; first, because it was probable that the work would be again undertaken, and, if so, because of the loss of many expert men, it was absolutely necessary to have a sufficient number of men capable of instructing the new hands; and, second those men were retained because, if they were not given employment, being bright men, capable, and the kind of men everybody desires in their own work, they would get other employment, and we would be handicapped with no one to train the new force. Again, each one of these men is capable in field work of earning his advanced pay, be it three or four dollars a day, because of his superior capability, reliability and experience. Especially is this true in the case of <u>expert field work</u>, which was largely the work in which these men were employed when the privates were not employed.

"Again, the committee says, on page 8: 'The system of scouting, necessary under the policy of extermination, is an expensive feature of the work, in its practical operation, barren of positive and justifiable results; and, as ordinarily carried on, a manifest waste of money. Dozens of men racing through the woods a hundred yards apart, with the avowed object of locating nests and noting evidence of the existence of insects, present a ludicrous and contemptible exhibition of inefficient management somewhere.' The fact is that no such scouting is done. The nearest approach to it is when men have been sent to examine woodland to locate colonies where work may be started in the clearing of such woodland. How is the committee or anybody in charge of this business to find colonies without such examinations?

"The investigating committee say, on page 10: 'Much of it (evidence) comes from unreliable and prejudicial sources, which hardly entitle it to a passing consideration.' Yet they have largely printed it here for the information or misinformation of the Legislature and the people. The fact is, Mr. Chairman, that a considerable part of the evidence, of the wasteful and extravagant expenditure of money, the lack of control of the men and bad management and loafing came from two witnesses, ex-employees, whom you, Mr. Chairman, heard here last year; and I want to say to you, having heard their evidence at both hearings, that it has enlarged several times over what they were able to give you then. From the nature of the case they can have had no further experience, and the enlargement of the evidence must be for a purpose. Mr. Chairman, doubtless you can obtain the evidence of these two men from the stenographer's report for the investigating committee, and, if you will take the trouble to look it over the compare it with what was said last year, you will understand to what I

refer. Mr. Chairman, you remember how little weight the evidence of these two men had with your committee last year. With the investigating committee, the case seems to have been reversed.

"On page 12 the committee says: 'patronage should not be held out as a reward for legislative action.' Patronage has never been held out by anybody with authority to offer it. If it has been done, it has been by those without authority, or by men having no connection with the service.

"In reference to the statement on page 17 of the estimate made by 'the Board, through its chairman' in 1894, I want to say that the committee is entirely unfair in its treatment of these estimates, for, by their own statement in this report, on page 11, it will appear that the conditions of the estimate have not been at all complied with by the Legislature; yet this investigating committee proposes to hold the gypsy moth committee or the Board responsible for that estimate, when their side of the proposition has not been fulfilled.

"On page 20 the investigating committee says: 'The committee herewith submit the stenographic report of that portion of the testimony of one witness containing his views of the published reports of the Board'; and say: 'The quotations from these reports we make a part of this report; the comments and criticisms of the witness are his own, and he alone is responsible for them. We make our own deductions.'

"It is to be noted that the committee accepted these quotations

from the reports without investigation as to their accuracy, and say: 'We make the quotations from these reports a part of this report.'

"In the first paragraph the witness quotes from an alleged report of 1890: 'We have thoroughly investigated the outskirts, and found but one case where it was beyond the limits of our first investigation.' Now, Mr. Chairman, I want to say to you that there was no report in 1890. This matter was not put into the hands of theBoard of Agriculture until 1891. The quotation could not have been in the report, for there was no report extant. Possibly he may have found a newspaper statement of what the first commission may have said, but the gypsy moth committee had nothing whatever to do with it.

"On page 21 this witness quotes from the report of 1891: 'In the fall it was found only one-tenth as many as in the spring.' What the report said was: 'It was found that in the section where they were most plentiful in the spring there were comparatively few, not more than one-tenth the number there were last spring.' An entirely different statement. Then, again, he quotes: 'If eggs can be gathered, few will appear in the spring, and can be easily destroyed.' But the committee said: 'The committee believes the work of gathering the eggs throughout the entire district infested should be completed in the most thorough manner before the appearance of the leaves in the spring. If this can be accomplished, we believe that the numbers of the caterpillars that will appear in the spring will be comparatively small, and that they will be so much scattered that they can be found and destroyed without the spraying of the trees and shrubs of the whole country.'

"Again, the witness quotes: 'Work throughout the season was so effective that all the large colonies have been destroyed.' While this language is correct, it is entirely misleading, for the report says, afterwards: 'There is still a large area in which the eggs have not been destroyed.'

"The quotations in reference to 1892 are not correct, but in themselves are not particularly misrepresenting, but other modifying statements are ignored, thus in effect misrepresenting the committee. The report for that year says: 'There are large areas of woodland in the infested towns, There are points in these forested districts known to be infested. There are probably other points where colonies have been established. There are about four hundred acres of woodland which will, if it is allowed to remain, continue to be an uncertain element in our problem.'

"The witness says, quoting from our report for 1893: 'The condition of the infested territory is better than last year.' What the committee says is: 'The condition of the worst infested territory is believed to be better than it was one year ago.' He quotes: 'The moth is now so rare in most of the towns that only by close inspection can it be found.' What the committee said is: 'As a result of the work already done, the moths are now very rare except in limited localities in the central towns of the infested district. But they are scattered here and there over a large part of this whole area, in small colonies such as started from the original importation by Mr. Trouvelot in Medford.' In the same report the committee says: 'In this territory are about twelve thousand acres of woodland which may be more or less

infested. Small areas here and there in the woodland are known to be infested, while others may be.' The committee also say: 'The committee had asked for an appropriation of $165,000 the year before, so that this work might be done, but they received only $100,000. Again in January, 1894, they asked for the same amount, but it was not given.'

"I will not take your time to go over all these quotations in order, but simply desire to call your attention to one other, under 1896, where he quotes from the report: 'With a little more money we can exterminate them all.' No such statement or sentence can be found in any report of the Board; the quotation is manufactured out of whole cloth. The committee that same year asked for $200,000.

"I now want to call your attention to the closing remarks of this witness, on page 23, where he intends to be understood that the committee have covered up or misrepresented the size of the infested territory by failing to mention the towns that have been infested. The facts are these: --

"Towns reported in 1891: Medford, Malden, Everett, Somerville, Arlington, Winchester, Stoneham, Melrose, Saugus, Revere, Chelsea, Cambridge, Belmont, Lexington, Woburn, Wakefield, Lynn, Swampscott, Charlestown, Lynnfield, Salem, Peabody, Marblehead, Beverly, Reading, Brighton, Watertown, Waltham, East Boston, Winthrop, -- thirty towns. Danvers was reported in 1893, Burlington in 1893, Boston in 1894, Nahant in 1895, Brookline in 1895, Lincoln in 1897, Manchester in 1898, Georgetown and Newton in 1899.

"Now Mr. Chairman, I submit that a partial quotation may be as misleading as a false quotation, and here we have partial quotations which misrepresent the position of the Board, and false quotations which have no foundation whatever."

The gypsy moth committee commented further in their report: --

"Your committee has no new recommendations to suggest, but refer you to our report of last year. If we should suggest them, they would look beyond the present to the future welfare of the State; they would appeal to the statesman who sees not the present alone, but the present and future as one. We made an appeal to the investigating committee of the Legislature of 1900. The appeal was ignored by the committee; the Legislature did not hear it. That the gypsy moth committee's position may go on record, we quote the language of the appeal:--

'And now, gentlemen of the committee, this matter is in your hands. We have fought a good fight. We have done the best we could with the means at our command. We know the pest should have been exterminated ere this. We have done all that we could to induce the Legislature to realize the economy of vigorous work with sufficient appropriations to secure it; but they have thought themselves the wiser, and because of their policy, extermination has had to partially give way to temporary expedients for holding in check. That was not our fault, and we are not at all responsible for it. No men could have done better work, no methods could have produced so good a result. We are proud of the record, and, under these conditions, more than satisfied with the measure of success. This old Board took

the burden unwillingly, and has labored diligently and with self-sacrifice for the good of agriculture, and therefore of the Commonwealth. If others can do this work better, give it into their hands at once, and I pledge the support of this Board to aid their every effort to the extent of our ability. We only plead for the extermination of this fearful pest, for the carrying out of this work to the end. Suppression is gradual expansion, -- nothing less and nothing more. It may delay for a few years, but its result is as certain as that night follows day. As I have said, this is the broadest, and most far-reaching, the most momentous question before any State Legislature in this country. It is not a question of politics and finance, it is a question of statesmanship and the future welfare of our country. We shall not live to see the blight of this insect stretching through our forest areas from east to west; but it will come if you decide to abandon the policy of extermination, and nothing can stay its destructive course, once escaped from its present limitations. You do not realize the danger from what you have seen, for our work has been so well done that you must turn back to Medford in 1890 or to the small colony in Georgetown to appreciate its destructive power. The farmers cannot and will not stay or control this pest. There is only one of two things,--exterminate, or let alone. We have proved to you by intelligent testimony that extermination is possible and assured, if the Legislature will not hamper the work. We have shown you that our methods are the only practical methods, and that they will accomplish the result. We have brought the most intelligent witnesses, from Berkshire to the Cape, to bring to your notice the strong sentiment of the State,--not farmers alone, but men in other callings with views

broad enough to grasp this great question. We realize the importance that will attach to your verdict. We have established every point. We have confounded every statement of political intrigue. We await your verdict without anxiety. We have done our duty without fear and without reproach, and if you call upon us to lay it down, we shall relinquish it with pleasure; only, as our last work, we pray you, for the good of theState in the future, for the good or coming generations, let the work go on, and history will applaud the broadness of your foresignt, the wisdom of your verdict.'"

The gypsy moth committee then added:

"Only one other point,--there has been expended more than a million dollars in the extermination of this pest. It is necessarily begun in the nature of experimental work, and wrought out until the system is acknowledged superior to any known. The national government solicited the privilege of exhibiting models of the spraying apparatus at the recent Paris Exposition, where they received the gold medal for excellence. This award attests their value. True, a million dollars seems a great sum to those who know nothing of the magnitude of the work performed in these nine years; and yet, if it has accomplished nothing in the extermination of the gypsy moth, the result in more effective and cheaper insecticides, as, for instance, arsenate of lead, and the improved machinery and appliances discovered and invented under the administration of this committee, and now in use all over the State for the destruction of the elm-tree beetle and other tree pests, with no patents to increase their cost, are and will be of more economic value to the State than all the money expended.

"The Board of Agriculture has done its work. The State of Massachusetts, who, through its Legislature, stopped the work when 'not a large colony' could be found and when extermination was in sight, has taken upon itself the responsibility, and there let it rest. This Board has no apoligies to make; it has given its best efforts and done its best work every day and every hour from the beginning to the end. It has given this work into the hands of a carefully selected committee. Their reward and its reward are the benefit to the people. One day in each fourteen has been set apart by this committee for careful investigation and consideration of means, methods and results. It looked forward confidently to the laurels that would crown its successful issue,-- the greatest work of this kind ever laid upon a board, or accomplished by a Commonwealth for the future good of a nation.

"The law of 1891 has not been repealed. This committee of the Board of Agriculture has not been discharged. The property of the State is in its care and keeping, with a special appropriation to meet the expenses that must accrue, until such time as the Legislature shall make known its will. Under our control an inventory has been taken, and is on file at this office. Personal property that would accumulate expense has been sold and the money turned into the State treasury. Due care has been taken of all other, that it shall not deteriorate or waste. As in duty bound, we herewith submit our report.

Augustus Pratt
Fred W. Sargent
John M. Danforth
John R. Avery
Wm. R. Sessions
James W. Stockwell"

The annual adoption by the Legislature of the "too little and too

late" policy in dealing with the gypsy moth problem on grounds of economy and its persistent unwillingness to accept or support the recommendations of the best experts of the time or the advice of state officials who steadfastly bore the responsiblity of conducting this pioneer project and the credit that it gave to an irresponsible and prejudiced opposition has cost theState and the United States dearly in money and damage by this pest as will be abundantly shown later in this report.

A warm tribute of honor and respect is due the Committee on the Gypsy Moth, Insects and Birds of the State Department of Agriculture and their subordinates for the heroic steadfast effort which was made in the interest of all the people of the State and which merited united support rather than failure.

Methods of Destroying theGypsy Moth Prior to 1900

It was recognized early that destruction of the egg clusters appeared to be one of the best means of exterminating the gypsy moth. They are relatively easy to determine and each one treated disposes at once of the necessity for finding and destroying a potential brood of hundreds of caterpillars. Furthermore, the season spent in the egg stage lasts through late summer, autumn, winter and early spring, allowing a period for extermination which contrasts with the short season when the insect is in the caterpillar stage and when treatment may be prevented by unfavorable weather.

Several methods were used to accomplish this purpose. At first, the clusters were scraped from the trees, gathered in cans or pails

and then burned. This method was not entirely efficacious since frequently the clusters were broken, and the eggs which dropped to the ground would hatch unhindered. Later a means for applying acids was devised, which enabled the men to destroy the eggs without removal of the clusters from the trees. The apparatus used consisted of a small tin case holding two bottles, each having a rubber stopper with a pipette arrangement for discharging the contents onto the clusters. (Plate XII, figure 2) One bottle contained a mixture of carbolic acid and turpentine, and other pure nitric acid. Application of the two acids in combination entirely destroyed the egg clusters. Although effective, this method was expensive, there was some danger of burning the men, injuring their clothing and any apparatus which was stored in the tool boxes.

It was soon discovered that low grade creosote oil applied with a brush answered the purpose satisfactorily. By adding a small percentage of coal tar to the creosote the clusters were stained so that the dark color indicated that all had been treated. The material was easily handled and application was simple and inexpensive. The material was carried in a receptacle which consisted of a tin can or box which contained two tubes. (Plate XII, figure 1) One of the tubes contained the creosote mixture and the other tube contained white paint. Each tube was stopped by a cork through which a small paint brush was thrust. Inside the can cotton waste was wrapped around the tubes to receive the droppings from the tubes and thus both paint and creosote could be carried with little danger of injury to clothing. The white paint was used to mark a tree or other object found to be infested. It was also the usual practice during the early years of

the work to paint a ring of white paint around each egg cluster to prominently mark its location in the woodland areas in the "outside" towns. (Plate XIII)

In heavily infested brush land the use of fire was resorted to, particularly in areas where eggs were thickly deposited on the brush close to the ground and in stonewalls. It was found, however, the heat was not sufficiently intense, even when oil was first sprayed from water pots upon the ground and the brush, to kill all the clusters under stones or in walls. A machine was then devised, called the "cyclone burner", to spray burning oil with an extremely hot flame. (Plates XIV and XIVa) It was a two man apparatus with a fifteen gallon tank and a long cyclone nozzled pipe and hose, burning "Paraffine gas" oil. Pressure was furnished by a Johnson hand pump mounted on the tank. With this equipment egg clusters deposited in the open on underbrush and in low, inaccessible places were destroyed. Care was necessary to prevent fires in woodland or buildings and this treatment of stonewalls had to be delayed until the larvae were hatching.

No efforts were relaxed to accomplish destruction of the insect during its larval stage and it was recognized from the experiences gained in combatting caterpillar pests both in America and Europe, that by use of banding materials on tree trunks caterpillars were prevented from reaching the foliage. Many types of bands were tried including printer's ink placed directly in the bark or on encircling cloth or tarred paper, various kinds of specially prepared tree ink,

so-called bird lime or insect lime, a German product called "raupenleim", and plain cloth or burlap. The ink and lime bands proved to be ineffective, and were soon replaced by "raupenleim", or its American substitutes. This latter type of material, when properly prepared, remained soft and viscid, definitely deterred caterpillars from ascending the trees to which it was applied, and required a minimum of attention throughout the caterpillar stage. Several instruments were used to apply these bands, including simple paddles or trowels, hand-squeezed horn-shaped devices, plunger machines which were operated some by hand and some by spring power, and piston types driven by a hand-turned geared cog or by screw power.

The use of burlap for banding became more generally adopted during the later part of the early State work. It was partly the result of observation that gypsy moth larvae ceased feeding, particularly during hot, sunny days, and gathered in sheltered places in tree cavities, at the base of the trees, or on the shady under sides of the lower limbs, even crawling some distance to find shelter where they remained until night. The burlap band, tied in the middle and folded over, provided the desired shelter and the caterpillars thus assembled were easily destroyed. (Plate VI) The burlap bands were useful each season through the pupal stage since they provided shelter for the full grown pupating caterpillars. In addition, the use of burlap avoided objection to the unsightly sticky bands and, in some measures, the objection by some to the use of poisonous spray. Two machines were invented for preparation of the burlap for use in the field. (Plates XV and XVa) One fitted with a corrugated -edged knife similar to a hay knife and run by a motor was used to saw the burlap

bolts into strips of the desired width, approximately eight inches. When putting the burlap on the trees it was found that it was easier to work with a tight roll of burlap supended by a string from the workman's shoulder. Another machine, operated by one man, was used to make these tight rolls by winding the material onto a reel under stress of pull over several fixed rollers. These machines were used the last two years of the State work and were great savers of tedious labor previously required to cut and roll burlap.

The effectiveness of burlap was improved by removal of rubbish and undergrowth around the trees; removal of loose bark on the trees; judicious pruning and trimming; treating and filling tree cavities. Different materials were used in sealing tree cavities; at first they were filled with stones and then cemented, later sods were used and, to avoid the possibility of the cement cracking away which would allow the caterpillars shelter for pupation and provide the moths with places for oviposition, sometimes the cavities were covered with tin or zinc closely tacked. (Plate XVI) These methods required considerable care to be effective and the importance and necessity of careful work was stressed continually.

Application of tree foliage of a poisonous spray was used for destruction or control of many insects and numerous experiments were undertaken during the entire period of State work before 1900 to discover and develop a satisfactory insecticide for use against gypsy moth caterpillars. Many materials, particularly the easily procurable arsenites, such as Paris Green and London purple, were found to

be deadly to the gypsy moth but only in strength which injured tree foliage. Detailed experiments included trials of these materials in varied strengths and in combination with other materials, and of several other compounds such as arsenate of zinc, cyanide salts, trade compounds containing arsenic, cyanide, tobacco, or other materials. None of these materials proved satisfactory. In the course of the experiments, however, arsenate of lead was developed which was easily prepared by dissolving separately in water proper amounts of arsenate of soda and acetate of lead and pouring the solutions together in the required quantity of water.

The arsenate of lead obtained by this mixture is a fine precipitate which is held well in suspension by the water and can be evenly sprayed. Many thorough tests were made of this material which gave early promise of its success, yet at first the arsenical fault of foliage burning hampered its free use and toxic strengths could not always be applied with safety. Continued research resulted in the discovery that the base materials were not always true to formula or were impure. Free arsenic was released in the mixture which caused foliage burning. This was corrected and during the later years of the early State work use of arsenate of lead for spraying became a general practice, particularly in woodland or on shade trees where large areas could be quickly protected in the short time of caterpillar feeding. The insecticide was prepared for application at the rate of 25 pounds of the arsenate of lead mixture (or 12-1/2 pounds of actual arsenate of lead) to 150 gallons of water, to which was added 4 to 6 gallons of glucose. After tests in 1898 it was determined the glucose had not more than a transitory effect and its use was discontinued.

The State prepared its own arsenate of lead up to the time the work ceased in 1900. The required amounts of arsenate of soda and acetate of lead were put up in heavy paper bags and taken to the site where spraying was to be done. Each material was dissolved in separate wooden pails partially filled with warm water. After the spray tank has been partially filled with water they were poured together slowly into the tank and a finely divided precipitate of aresenate of lead was formed. The tank was then filled and spraying begun. It mixed readily with the water after moderate agitation and the spray adhered well to the foliage. Later the method of manufacture was improved and the material was offered to the public by commercial interests in the form of paste containing approximately fifty per cent of water and rapidly replaced all other insecticides for treating foliage for leaf-eating insects. Much of the development and improvement work was carried on by Mr. F. J. Smith, the chemist of the Board of Agriculture, and the testing of its effectiveness was conducted by the writer.

The use of arsenate of lead soon resulted in the development of better spraying apparatus. Small hand pumps of low pressure mounted on barrels of about 50 gallons capacity were superseded to some extent by use of hogsheads, holding approximately 150 gallons, mounted on wagons. (Plate XVII) Later an "automatic power sprayer" was adopted for use on the work. This consisted of a 60 gallon tank suspended between two wheels with attached gears lwhich furnished power to the pump handle by means of a shaft when drawn by a horse. (Plate XVIII) The pump could be disconnected and operated by hand when the machine was standing. After arsenate of lead had proved to be effective

further improvements in spraying machinery were made and a pump, built on the principle of that used in hand fire engines of the day, was installed in a 100 gallon cypress tank which was mounted on a specially designed truck with a device for lowering or raising the tank as desired. (Plate XIX) For spraying, a "Monitor" nozzle with four outlets was used which made it possible to cover both the under and upper surfaces of the foliage more thoroughly than was possible with the usual single Vermorel or cyclone nozzle. (Plate XIX) With this outfit a tripod arrangement was used (Plate XIXa) for spraying trees of medium height so that a large amount of climbing was avoided.

Many times it was advisable, particularly in very heavily infested colonies situated in woodland of slight value, to destroy all vegetation. In other instances it seemed best to practice less radical treatment by chopping clear and burning only the underbrush and worthless trees, leaving the more valuable larger trees. Clear cutting and burning was usually resorted to only when such vigorous measures appeared to be the sole remaining economical means for the immediate protection of uninfested surrounding woods of greater value. In the more valuable woodland, after clearing and burning the undergrowth, the standing trees were banded so that if the burning did not kill all egg clusters, the caterpillars would be starved out and the foliage protected.

No worth-while or practicable method of killing the adult moths was found, although the possibility of trapping male moths was explored to determine if a large proportion of the females would be compelled to lay infertile eggs, thus reducing the caterpillar population

the following season. One of the most effective traps, called the "Shaw" trap after its inventor, Mr. H. J. Shaw, (Plate VIIa) had a small wire cage, in which freshly emerged female moths were confined to act as the attractant, placed at the base of a four-leaved wooden frame on which a sticky material was applied to catch the male moths. The number of male moths thus trapped varied according to the intensity of infestation at the location where traps were placed, but experimentation proved that a single male moth might fertilize several females and therefore the results of this means toward extermination did not indicate the cost and effort was feasible, and moth trapping did not become a part of the regular extermination program.

Practically all scouting was intensively done, tree by tree, and all likely places for concealment of egg clusters were thoroughly examined. Each scout carried a tin can containing a tube of creosote and a tube of white paint which has been previously described (Plate XII, figure 1), and a hand mirror (Plate XII, figure 4) for reflecting light into cavities and crevices or to look under fence boards and rails near the ground in search of concealed clusters, and a special knife for use in marking trees examined. (Plate XII, figure 3)

Scouting crews travelled in a line abreast, spaced apart at distances depending upon the amount of tree growth to be examined. The crew, checking on the work and keeping the men in line so that no trees would be overlooked.

The following table shows the amount of funds requested and appropri-

ated from 1890 to 1900 and the dates on which these funds were made available by the State of Massachusetts for gypsy moth extermination work.

Year	Amount Requested	Amount Appropriated	Date
1890	$50,000	$25,000 25,000	March 14, 1890 June 3, 1890
1891	50,000	50,000	June 30, 1891
1892	75,000	75,000	March 1, 1892
1893	165,000	100,000	April 12, 1893
1894	165,000	100,000	May 23, 1894
1895	200,000	150,000	May 17, 1895
1896	200,000	10,000 90,000	April ; 28, 1896 June 4, 1896
1897	200,000 (1	150,000	February 26, 1897
1898	200,000	20,000 (2 180,000	February - 1898 April - 1898
1899	200,000	30,000 170,000 (2	February 15, 1899 April 15, 1899
1900	200,000	18,000 (3 1,000 (4	February - 1900 May - 1900
Total	$ 1,705,000	$ 1,194,000	

(1 - Prof. Fernald's estimate of cost to complete the work made in January, 1897. Recommended $200,000 each year for 5 years, then $100,000 each year for second five years, then $15,000 each year for third 5 years.

(2 - Including $10,000 for brown-tail moth work. Balance for gypsy moth, $190,000.

(3 - No regular appropriation was voted by Legislature for work in 1900, but under the then existing Massachusetts law the state departments

could incur expenses in January each year at a percentage of previous year's apporpriation, pending legislative action fixing the new appropriation. This sum used for field work in January and to close up the field work during February to May.

(4-Made available for custodial purposes and miscellaneous expenses of the gypsy moth committee from May to December 1900. No field work authorized.

Appendix A

REPORTS OF ENTOMOLOGISTS WHO VISITED THE INFESTED REGION IN 1893.

Report of Dr. A. S. Packard of Brown University, Late of the United States Entomological Commission.

Providence, R.I., June 19, 1893

Prof. C. H. Fernald

My Dear Sir;- Having been asked to give my impressions of the work now being done at Malden and vicinity in exterminating the gypsy moth, I will say that it made a good impression on me, and I have no adverse criticisms to make. Mr. Forbush seems exactly adapated for the work intrusted to him. I was struck with the ability shown in organizing and systematizing the whole work, and the readiness and interest shown by the men under Mr. Forbush. The office and its system, the storehouse and its apparatus, interested me very much, and the new and ingenious devices for spraying and in other ways destroying the eggs and the worms. It seems to me the work is practical and thorough throughout, and must bear good fruit this season.

In the short time I spent I saw nothing to find fault with, but much

to commend. I say this without wishing to merely say something pleasant, but because I mean it.

Yours very truly,

A. S. Packard

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Report of Dr. J. A. Lintner, State Entomologist of New York.

Office of State Entomologist
Room 27, Capitol, Albany
June 22, 1893.

Prof. C. H. Fernald.

My Dear Sir;- The two days that I passed last week, in compliance with the request of the gypsy moth committee of the State Board of Agriculture and of yourself, in inspecting the operations of the committee through its director, Mr. E. H. Forbush, were highly gratifying and satisfactory to me. I was not prepared to see that such progress had been made toward the extermination of the notorious gypsy moth. It was a surprise to me that in the brief space of three years the fearful ravages of the insect as described to me and as pictured in photographs could have been reduced to such a comparative harmlessness that to the ordinary observer no indication of its presence was visible, and that in a ride of an entire day through several of the "infested towns," including a visit to localities which had been frightfully scourged, not a single example of the caterpillar was found by me, although diligent search for it was made.

How a work of such magnitude, extending over so large a territory, could have been accomplished, was a wonder and enigma to me,

until I became acquainted with the means by which it had been brought about. These are in part:-

First. Your work at the insectary is largely supplementing that being conducted at the Malden headquarters. I regard it so exceedingly valuable and so absolutely essential to the best results in field work, the one to check and therefore to aid the other.

Second. The committee, I am confident, have been both wise and fortunate in their selection of Mr. Forbush as director of field work. I think that I estimate correctly when I say that he is eminently fitted for the important and responsible position. A high degree of judgment and discretion has evidently been exercised in the selection of those employed by him and the retention of those best qualified for the duties assigned them. The executive ability displayed by him in the organization of his force, its direction, guidance, supervision, equipment, accountability, etc., seems to me remarkable and to go far toward the accounting for the singular success that has attended his administration.

Third. The "Storehouse" greatly interested me. It may properly be called an "arsenal", for it is furnished with all the appliances needed for conducting in the most effective manner the warfare in which you are engaged. In it are found not only all of the more important instruments and materials that economic entomology had tested in former years but many new ones, called into use for the first time, as the need had become apparent and the ability for their

conception and production was at command.

With such means, as above indicated, your State, which has been liberal in its appropriations, has a right to expect ample returns. It will not be disappointed, for you have already accomplished more than could have been reasonably expected.

I trust that your Legislature will see the wisdom of continuing the work under suitable appropriations, until the extermination of the insect has been attained, or at least until it shall have been reduced to entire harmlessness, and in position never again to develop in injurious numbers or to invade other States.

I have been asked to offer such criticisms or suggestions as I might deem it proper to make. I have found nothing to criticise, but, on the contrary, have received instruction from what I saw.

Under the permission given, I will offer two suggestions: -

1. As what may be called the mechanical details of field work, as burlapping, liming, spraying, egg collecting, etc., are steadily diminishing, there will be the greater need (as well as the opportunity) of scientific work, to round up, as it were, the labors of the committee to aid it in its completion, to render it available for future use wherever the necessity may arise in this or similar insect invasions, and to make such a contribution to science as Massachusetts has ever been ready to do when the occasion has offered.

I would, therefore, suggest (and recommend, if I dare venture to do so) that the committee, if possible, avail themselves of more of your time and service. Your habits of thought, observation and study seem specially fitted to the work that you are now conducting for the committee. Further, the experience that you have gained is of so great value that it should not be lost to them. I do not, however, see how this could be brought about under your existing relations with the college and agricultural station. I am sure that there is an ample field for your entire service. If the committee could offer you a sufficient inducement, it is not possible that, while retaining your connection with the college and station, you could be released from the discharge of the duties, say for two or three years, and devote yourself wholly to the gypsy moth? So positive am I of the utility of such an arrangement that I sincerely hope that it may be accomplished.

2. Just at this stage of the committee's work I would suggest that the cultivation of the parasites of the gypsy moth be entered upon and conducted with all the knowledge and skill that can be brought to bear upon it. Far more is to be hoped from this than from the costly and problemantical search for and importation of its European insect enemies. Nearly a score of native parasites are already known to prey upon it, and we may expect this number to be materially increased. Something like the following method of cultivation might be pursued:-

Collect the pupae as soon as they are to be found so as not to give opportunity for the escape of the earliest maturing parasites.

None should be destroyed, but carry all carefully to headquarters at Malden, suitable provisions having been previously made for their reception and care.

If 80,000, as reported, were collected last year, perhaps from 15,000 to 20,000 might be secured this year. Arranged in a single layer, a case not exceeding twenty-five square feet of area would be ample for them, and leave space at one end for feeding larvae.

By means of cold storage, delay the development and emergence of the parasites until larvae are in readiness in which they may oviposit.

Egg-clusters collected this season shall be so regulated by temperature that they will give out their larvae as soon as food is obtainable for them.

With the feeding larvae in one part of the case with the pupae, they will at once be found by the parasites and all of their eggs deposited in them if the larval supply is proportioned to their need.

When the parasitism is finished, the larvae may be fed in confinement to maturity, if practicable, provided that conditions favorable to the prevention of disease or other fatality can be given them; or they may be transferred to isolated trees selected for the purpose, where they may complete their growth and be protected from destruction by birds byinclosing the trees in netting. The follow-

...

ing season the parasites, unless desired to extend their multiplication by again rearing them in confinement, may be permitted to escape and seek their prey abroad.

The parasitized caterpillars might be conveyed to the localities where the parasites are the most needed.

Gathering the parasites from the case after their death would give every species which was parasitic on the larvae and pupae (except such as may have emerged from the larvae), and their proportionate number, from which the most efficient could be ascertained. Examination would also show the proportionate number of pupae that had been destroyed by parasites.

The above plan may not have been properly digested by me, and there are no experiments of the kind to serve as a guide. So far as I know it has not been attempted on a large scale (the multiplication of icerya parasites in California was somewhat similar), but if done with the knowledge that you could bring to bear upon it, I am sanguine of its success. Possibly by this means only can the desired extermination of the gypsy moth be attained.

If, under the existing law, the carrying of the living insect from one town to another is prohibited, amendment for the above-named purpose could no doubt be secured.

Very truly yours,

J. A. Lintner

Report of Prof. John B. Smith, D.Sc., of Rutgers College

State Entomologist of New Jersey

New Brunswick, N. J.
June 20, 1893

Dear Dr. Fernald:- Since my return to New Brunswick I have been thinking over what I saw of the work of the gypsy moth committee near Malden, Lynn and Swampscott, and with the lapse of time my admiration for the work accomplished has increased rather than diminished. When I received your invitation I was, I think I can truly say, free from actual prejudice, yet with a disposition to believe that the work of the committee was palliative merely, and that actual extermination was impossible, an impression to which I had given public expression. I am pleased to say that I have seen ample evidence to induce a change of opinion, and my belief is now that if the committee is as well supported as it deserves to be it will accomplish the end for which it was created. With this expression of my present belief, you will understand that my suggestions are not in the nature of adverse criticism.

First, concerning the experiments in progress at Amherst, at the present time. These consist of a test of the action of certain insecticides on larvae of all eggs, and in contemplation are experiments concerning possible parthenogenesis, fixing the relative time of issuing of the sexes from one batch of eggs and the effect upon the fertility of the eggs of close breeding,—that is, between males and females bred from the same egg-mass.

All these experiments are not only of the highest scientific in-

terest, but also of the utmost practical importance.

If parthenogenesis is possible, the danger of spreading the insects by carrying off single specimens is vastly increased, and the most stringent measures to prevent such distribution are justified. While parthenogenesis in the Lepidoptera is extremely rare, yet cases have been recorded in the same natural group to which this insect belongs, and the inquiry is therefore by no means a merely curious one.

Fixing the relative time of the emergence of the sexes of the same brood is of very great importance, for, if males and females issue at such intervals as to make it unlikely that they can pair, the danger from distribution of even several larvae from the same batch of eggs is materially lessened.

The determination of the effect of in-bredding is equally important, for much the same reason.

Finally, the experiments with insecticides are of peculiar interest, from the fact that the caterpillars seem unusually resistant to the action of arsenic in doses fatal to most of the insects known to us.

There is one criticism to be made on all the above experiments: they are on too small a scale to render the results altogether convincing and they are made in the wrong place at Amherst rather than at Malden, Lynn or elsewhere in the infested region. The extreme caution necessary to prevent the escape of specimens of the larvae prevents

the practice of certain lines of out--door work, the results of which would supplement the in-door or laboratory experiments.

I would therefore suggest that the experiments now carried on at Amherst be duplicated or transferred to some point within the infested district where material is more abundant, and where there is no danger of introducing the insect into new localities.

These experiments must of course be made by a trained entomologist, or by a competent man under detailed instructions. By all odds the most satisfactory plan would be to have you carry on the experiments yourself, for they would then command universal acceptance and would be generally regarded as conclusive.

The result of the insecticide experiments thus far is so unusual that I would recommend a further series of experiments to determine exactly what becomes of the arsenic eaten by the insects; whether it is absorbed or whether it is excreted, and how much arsenic an insect will contain when its intestinal canal is filled with poisoned food and excreta therefrom. This could be done by feeding larvae on leaves sprayed with a maximum amount borne by the foliage for say three or four days, and then substituting fresh food free from poison. A chemical test should be made thereafter every day or every day or two to ascertain the presence or absence of arsenic in the larvae. Microscopic examinations of the digestive tract of poisoned larvae should also be made, and should be compared with that of healthy larvae, to ascertain whether any lesion were caused that might result in a de-

generated adult. The excreta of larvae fed upon poisoned food should also be analyzed to determine the amount disposed of in this way.

This is of course suggestive merely; but in my opinion the present occasion is an unusually good one to gather a mass of facts whose importance to economic entomology it would be difficult to estimate.

If I had reason to speak in approbation of the line of experiments laid out by yourself at Amherst, I found very much more to admire in the infested district, in the actual field work under the direction of Mr. Forbush. The mere organization of the force and the plan of the work is excellent; as to the results of the methods adopted, the fact that in the entire infested district visited by me -- Malden, Lynn and Swampscott -- only a single half grown larva was discovered speaks loudest.

I was extremely interested in the office organization, in which the system of entering and classifying reports enables the director and the members of the committee to determine at once the exact condition of affairs in any district. The notes of observations made by inspectors are many of them of the greatest interest, and merit editing by an entomologist capable of recognizing facts and separating them from inferences made by the observer.

The inspection of the tool-house was a revelation in the variety of apparatus it afforded, all of it adapted to the special end in view.

The practical value of all the apparatus is obvious, and while for an orchard the spraying outfits might be considered clumsy and somewhat wasteful, yet when the character of the work is considered the apparatus designed for the fruit grower is manifestly insufficient. A most commendable feature in the work has been seeking out means of taking advantage of the peculiarities of the insect's habits, which is, after all, the most philosophical way of accomplishing the work in hand.

It would be altogether to long a task to go into details concerning the outfit of insecticide machinery, and I need only say that I can find absolutely nothing to suggest in the way of improving the methods of work.

The force under the direction of Mr. Forbush has accomplished wonders, and I feel now that there is very good reason for the belief that the gypsy moth can be exterminated, provided the means are furnished by the Legislature of Massachusetts in as liberal a spirit at least as past appropriations have been made.

I have been asked to give an opinion on the feasibility of introducing European parasites of this insect, to keep it in check. I feel very decidedly that this would be money wasted. This and its ally, the Nonne, are frequently destructive in Europe, and if its parasites do not succeed in mastering it there, there is no good reason for believing that they can do better here.

Nature never works for the extermination of any of its creatures,

and if parasites ever exterminated their hosts the parasites themselves would be exterminated for the want of food. A balance is all that nature aims for. A parasite which would be able to exterminate the gypsy moth in this country must be one that would prey on this one insect only; and even then it is very problematical whether the result would be very satisfactory, for to enable the parasites to do their work, artificial means of destroying the larvae would have to be abandoned for fear of killing the parasites as well.

I am very strongly of the opinion, therefore, that nothing can be gained by an attempted introduction of parasites.

The oft-cited case of vedalia destroying the cottony cushion scale in California can have no application to this case, for the circumstances there were so peculiar that they can rarely be duplicated, and are not similar here.

I am asked to express an opinion as to the work done and to be done by the committee. I can only repeat what I have already said,-- the work done by this committee as at present organized is admirable, and I am unable to point out a method in which it could be improved.

Both the entomologist and the director thoroughly understand the problem, and are working for success,-- a success that I now think they will attain.

As to the work yet to be done, I am not in a position to give an opinion, because I had no time to cover the entire ground. From

what I could see at Malden, Lynn and Swampscott, I believe that for at least two years more a full force of men should be employed, using the methods that have proved so successful and working from the outer limits toward the central district.

The most useful men should in all cases be retained from year to year, for they will be worth at least double the sum any new men could be valued at, and will know just exactly what is to be done in all cases and just what to look for. After a few years the force of men could be safely reduced to the inspectors and a few ordinary workmen, whose principal business would be a continuous examination of the once-infested district, prepared to destroy any isolated brood that may have excaped; and finally this force could be reduced to the director and a very few inspectors, who, with the experience gained, could easily command the entire region until lapse of time proved the insects exterminated.

Very truly yours,

John B. Smith

Dr. C. H. Fernald, Entomologist, Gypsy Moth Commission, Amherst, Mass.

Report of Prof. Clarence M. Weed, D.Sc. of the New Hampshire College of Agriculture and the Mechanic Arts, Entomologist of the Agricultural Experiment Station

Hanover, N. H.
June 16, 1895

To the Gypsy Moth Committee.

Gentlemen: - In response to the invitation extended by you through Professor Fernald, I recently visited the various departments of gypsy-

moth work, and beg leave to inform you of the impressions thus received.

I first inspected the work in progress at the insectary at Amherst, and found that a series of experiments with remedies was being conducted under the most careful conditions; in fact, I have never seen a series of similar experiments carried on in so large a scale in so thoroughly scientific a manner. They ought certainly to furnish reliable results, which will be of great value outside of the gypsy moth work.

I next went to Malden, and in company with the other visitors, Professor Fernald, Mr. Forbush and Mr. Reid, looked over the ground carefully. The general impression received was very favorable as to the amount and methods of work. The results already reached seem to be remarkable, and I was greatly surprised at the scarcity of gypsy caterpillars. The methods of fighting the pest have evidently been developed along with the knowledge concerning it, and are well adapted to the end in view.

The only suggestion I have to make concerns the lack of adequate facilities for studying the life history of the pest at headquarters. It seems to me that if a room adapted to the purpose could be set apart, and a man of entomological training be detailed to make out the biological points yet in doubt, valuable results might be reached. I should suppose that it would hardly be necessary to call in an entomologist of note if Professor Fernald is willing to supervise the work of the one detailed to carry on such observations and experiments. In fact, the results would have an added value if carried on both at Malden and Amherst under one direction.

I was especially interested to learn of the results that have been reached with the arsenate of lead. Even if it does not kill gypsy caterpillars as quickly as does Paris green, it seems probable that it will make a valuable insecticide for many other purposes.

Thanking you for the opportunity you afforded, and assuring you of whatever support I may be able to render, I am

Yours respectfully,

Clarence M. Weed

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Report of Dr. H. T. Fernald, of the Pennsylvania State College

State College, Centre County, Pa.
June 19, 1895

To the Gypsy Moth Commission.

Gentlemen: - In accordance with your request, extended to me by Prof. C. H. Fernald, I have examined the work in progress at Malden and Amherst, and am both interested and pleased with what I have seen.

Previous to my visit to Malden I felt some doubt as to whether it was possible to exterminate the gypsy moth, as I had had some previous knowledge of it and of its ravages in Massachusetts, being at Amherst when it was first reported to the experiment station there in 1889, and having carefully looked over the matter at that time. Since my visit a careful consideration of the methods used and of the results already obtained has convinced me that extermination is not only probably, but certain, if the work be prosecuted for a sufficient length of time.

On one or two points I have gathered impressions which may perhaps be worthy of mention here: -

1. I think that the position so far held by the committee with reference to the effect of parasites is a wise one. I have never heard of a case where an insect was exteriminated by its parasites, the relation of the two forms at any one time being in numbers very close. A reduction in the numbers of the host is always followed by a similar reduction in the numbers of the parasites, leaving to those individuals of the host which have escaped an opportunity for rapid and unchecked increase until overtaken by a corresponding but later increase in numbers of the parasites. For this reason parasites cannot be relied upon to do the work needed in the case of the gypsy moth.

2. The method of burning over infested areas in connection with burlapping the trees seems to me to be a most effective method of procedure if the precaution of burning for a sufficiently great distance beyond the limits of the infested area be carefully observed. My impression is that the edge of the burned area should always be at least two hundred feet outside these limits, as far as these can be ascertained.

The work so far accomplished shows on its face that the methods in use are the result of experience, and that they are most efficacious.

It seems to me that two things are greatly to be feared:-

1. That the time is near when searches with negative results may tend to produce carelessnes on the part of the searchers.

2. That the apparent disappearance of the moths may lead the Legislature into the error of abolishing the committee at the time when its work will show the fewest results, but will in reality be the most valuable,--in fact, would be absolutely necessary to insure the prevention of some future invasion.

The work done by the committee in the way of testing insecticides in the field at Malden and in the laboratory at Amherst is of great value, and the importance of learning with the greatest accuracy just how successful each method is, cannot be everestimated. The care with which the experiments at Amherst are conducted guarantees the accomplishment of this most important task, while the discovery of a new insecticide with the properties which the arsenate of lead apparently possesses must certainly be worth more to the State than all the money it has spent for the extermination of the gypsy moth.

Yours respectfully,

T. H. Fernald.

Appendix B

REPORTS OF ENTOMOLOGISTS WHO VISITED THE INFESTED REGION IN 1894.--

OPINION OF THE UNITED STATES ENTOMOLOGIST.

Report of Dr. George H. Perkins of the University of Vermont, Entomologist of the Vermont State Agricultural Experiment Station.

Burlington, Vt.
July 10, 1894

Prof. C. H. Fernald.

Dear Sir: - In accordance with your invitation to visit the region infested by the gypsy moth, I went to Malden, as you are aware, and through the very cordial assistance of both yourself and Mr. Ware, assistant director, was enabled to see in a most complete and satisfactory manner the appliances used and the various methods of using them.

I wish to express my appreciation of the thorough and careful manner in which the work was being done, and the evident desire of those engaged in it to execute the trust committed to them as faithfully and economically as possible. No work of the sort which I have ever seen or heard of has impressed me as favorably as did that of the officials engaged in the work of exterminating the gypsy moth.

The whole nation should be grateful to the committee for what it has already accomplished; for it is my belief that, had not the work been so well done in Massachusetts, the insect would ere this have spread beyond the borders of that State and now threaten the whole land. It is most gratifying to find, instead of this, that the ravages of the moth have been very much reduced by the efforts of the committee.

No one interested in economic entomology can investigation the work in office and field without at once discovering that a vast amount of very useful information has been gathered which should not on any account be lost to science. On this account it is very greatly to be desired that as full and complete a report as possible of the work of the committee be published, for much that such a report would contain would necessarily be of general and permanent value.

The question has been asked, Is it possible to exterminate an insect which has become so abundant as the gypsy moth? Before I visited the infested region, and saw what had already been done, I was quite doubtful as to the expediency or the possibility of extermination; but after investigation I thought differently. It seems to me very clearly the wisest and most econimical course, for the present at any rate, to continue the work as it is now going forward, and aim at extermination. The men and the methods now employed are so successful that it would be unwise to discontinue them for several seasons to come.

It also seems to me that the functions of the committee might be very advantageously extended, so that in their discretion they could direct their destructive agencies against such other insects as might be easily taken in hand.

When passing through some of the towns infested by the gypsy moth we notice many trees of foliage of which had been wholly destroyed by the canker-worm and many of these trees could have been sprayed by those engaged in spraying neighboring trees for the most at small cost of time or money.

In one instance in the early autumn of [illegible] the work to which this relates, it was discovered that a very small amount of very light impurities had been collected which should not on any account be left to remain. In this account it is very greatly to be desired that we full and complete report of [illegible] of the work as the case [illegible] politely, for upon that stage a report would undoubtedly be of general and permanent value.

The question that then arises, is it possible to distinguish between cases where the [illegible] of the spray water [illegible] the internal region, and the [illegible] done, I am quite [illegible] as to the originality or the [illegible], but [illegible] I cannot definitely. It seems to me very clear- ly the object was [illegible] cases, for the present at any rate, to continue the [illegible] use going [illegible], and all at a low rate. The men not use as [illegible] and as economically that it would be better to discontinue them for several seasons to come.

It also seems to me that the [illegible] of the operations might be very advantageously [illegible], so that in [illegible] they could also a short instruction [illegible] against such other insects as might be easily taken in hand.

Upon leaving through some of the trees [illegible] by the grub to [illegible] many [illegible] of foliage of which had been easily overcome by the [illegible] and many of these trees would have been stripped of their foliage in a few [illegible]. Even the [illegible] most of them or [illegible].

It was very evident that private enterprise could not be depended upon to deal with these pests. It is my own conviction that the most efficient and the cheapest method of dealing with any insect which has become numerous and destructive is that adopted in the case of the gypsy moth, not leaving to private citizens the too great task, and thus ensuring failure, but bringing the authority and the resources of the State to the work, and carrying it forward to success.

Is it not probably that, had the gypsy moth not been stayed in its destruction, the loss of property through the destruction of shade and fruit trees would have been more than the cost of extermination has thus far been?

It is to be hoped that the work so well done thus far will not now be suffered to lag through lack of either funds or popular support. There is every reason for continuing it, while to stop or reduce it would be a great calamity.

I have not been asked to praise the work of the committee, but rather to suggest improvements in their methods, and to criticize whatever I might find deserving it. I have no criticism to offer, nor am I able to make suggestions other than those given above.

I am, sir,

Very truly yours,

Geo. H. Perkins

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It was very evident that certain enterprise would be determined upon to deny this view. It is my own conviction that the most efficient and the cheapest method of dealing with any dissent which has before manifested any opposition is that adopted in the case of the Jury Acts, not leaving to private defence the first onset, but then employing failure, and regarding the authority and the resources of the State to the end, not merely to repress violence.

So it has probably been, and the copy with not even changed in its particulars, the idea of property survey, the description of lands can [illegible] would have been here then the case of [illegible] the Lord.

It is to be hoped that the suit to well have been [illegible] to achieve to the borough laws or letter rights or [illegible] part. There is every reason for continuing it, while to stop or reopen it would be a great calamity.

I have not been asked to print the work of the committee, but rather to suggest the remedies to their methods, and to criticise whatever I shall find [illegible]. I have no criticisms to offer, nor do I wish to make suggestions other than those given above.

I am, sir,

Very truly yours,

Geo. F. Hoar.

Report of Prof. F. L. Harvey of the Main State College, Botanist and Entomologist of the Maine Experiment Station, Orono, Maine

To the Members of the Gypsy Moth Committee of the State Board of Agriculture of Massachusetts.

Gentlemen: - In compliance with your courteous invitation (extended to me through Prof. C. H. Fernald) "to inspect the work of the gypsy moth committee and give my impressions and advice," I visited Malden the latter part of July, and spent two days examining the work of the committee in the office, laboratories and field. Through the courtesies of Director E. H. Forbush and others of the department every opportunity was afforded me to gain a thorough knowledge of the scope and character of the committee.

I went of Malden with an entirely inadequate conception of the territory affected, and the stupendous undertaking of the committee to reduce or exterminate the gypsy moth. I first visited the office, and was surprised by the ingenuity and thoroughness displayed in keeping the field notes and indexing them for ready reference. A mass of information regarding the habits, natural history and anatomy of this insect has been accumulated by Professor Fernald, Director Forbush and their assistants. This seems so important that for the good of entomological science it is hoped it may be sifted by a competent entomologist and published as a monograph by the committee. The pains taken in examining the men for field work and the almost military exactness required of them in their labor and reports reflect great credit upon the organizing ability of the director, and speak much for the efficiency of the service.

The work being done in the laboratory and insectary upon the life-history of the moth, its parasites and histology, and upon remedies, was timely and thorough. I was especially interested in the histological work, conducted by Mr. A. H. Kirkland, to determine if possible what becomes of the arsenical poison the full-grown larvae are known to eat with impunity, and also the trap experiments under the direction of Mr, Kirkland.

The storehouse of apparatus and supplies impresses one with the magnitude of the work, and is instructive in the novel apparatus invented to fight this pest.

The results obtained in the experiments on insecticides, by Mr. F. C. Moulton, are most important, and bid fair to be of great usefulness to economic entomology.

The field methods of searching for the eggs, larvae and pupae, the burlapping of the trees and the careful burning of infested areas was thorough and practical.

Upon the whole, the methods which have been born of experience and adopted by the committee for coping with the pest impressed me as ingenious and effective. I have no criticisms to offer upon the work of the committee, and regard the results obtained as marvellous.

Entomologists are generally agreed that it is impossible to exterminate an insect by means of parasites, so all that can be hoped for in this direction is <u>uncertain</u> aid in holding it in check. Whether

it is possible to exterminate an insect by persistent and thorough hand-picking, use of insecticides and fire is problematical, because it has never been tried. It is a plausible problem, which we hope, for the good of economic entomology, the gypsy moth committee may have the opportunity to settle. By the efficient work of the committee, in three years' time, this insect, which was legion and doing great damage over a wide area, has been reduced beyond detection by common observation. We spent a whole day in the field, and, though constantly on the alert for specimens, saw only four male moths and no larvae, pupae or eggs. So thoroughly has the work been done that intelligent people in the district wrongly regard the work of the committee accomplished. It is the scattering colonies, the last one per cent., that will demand more thorough work than the other ninety-nine percent., and your Legislature and citizens will need to be thoroughly impressed with this fact.

Two policies present themselves: first, whether an attempt be made to fight the moth to the finish; second, whether an attempt be made merely to keep it in check, and prevent an increase to harmful numbers.

The gratifying work of the committee so far would suggest continuance in the good work, with the idea of extermination. This would absolutely require the employment of a force of men large enough to keep the whole infested area under constant surveillance for some time. The present number of men employed seems to me to be inadequate,

as large areas in the infested district have to be neglected while inspection is going on in others. Unless a large force can be kept constantly employed for some years, the idea of extermination will have to be abandoned by the committee.

If the second policy be adopted, then the work of the committee for the present is practically done. Yet a permanent force would be needed to keep the area under occasional surveillance, and its energies directed to checking local outbreaks. This would be an interminable job, constantly menaced with the danger of the pest spreading over large areas to adjoining States, until so widely disseminated as to be beyond human power to control. It would seem to me to be wiser to attempt the extermination of the pest while in its greatly reduced numbers by the adoption of a liberal financial policy, than to drop the work and in a decade or sooner have it to do over all over again.

We regret to learn (unofficially) that naturalists are breeding this pest for the purpose of study outside of the Commonwealth of Massachusetts, in defiance of the strict laws regarding its dissemination.

I heard the committee criticised by citizens and others because they would not destroy other injurious insects besides the gypsy moth in the infested district. We understand this criticism to be unjust, as the Legislature confined the duties of the committee strictly to the suppression of this one insect, and to use the money to destroy the others would be a perversion of funds.

That it would be a wise policy for every State to have an entomological commission, with duties as broad as the requirements of economic entomology, we have no doubt. The fact that the gypsy moth committee has paid strict attention to business is the reason why they have in such a short time accomplished so much.

In closing, I desire to thank the committee for the opportunity offered me to study the life-history of this insect, and to become familiar with the ingenious and effective methods used in coping with it. I hope the committee will receive the financial support from the Legislature that will enable it to succeed in this stupendous undertaking, which does not alone interest Massachusetts but also the adjoining States and the whole country.

Respectfully submitted,

F. L. Harvey

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Report of Prof. John H. Comstock of Cornell University, late United States Entomologist.

Ithaca, N. Y.
July 17, 1894.

Mr. William R. Sessions, Secretary of the Committee on the Extermination of the Gypsy moth of the State Board of Agriculture.

Sir: - In compliance with the request of your committee transmitted to me through Professor Fernald, I visited the region infested by the gypsy moth, and spent several days studying what is being done towards the extermination of this species. During the greater part of this time I was accompanied by Professor Fernald and Mr. E. H. Forbush, who explained to me very fully the details of the work.

[illegible] would be a very [illegible] for every [illegible] to have to [illegible] should [illegible] write [illegible] [illegible] [illegible]

I was filled with admiration of the work that is being done by these gentlemen, and, although I have given the matter very careful thought, I am unable to suggest any changes in their methods. It seems to me that the methods they are following are the best possible, so long as the object of the work is the extermination of this insect.

But after going over the infested region, I have come to have grave doubts as to the advisability of attempting to exterminate this pest. I am not prepared to say that I consider extermination impossible, but it seems to me that the attainment of this desired end is highly improbable. It is true there are certain peculiarities in the habits of this insect that give hopes of the possibility of extermination. Thus the slowness with which the species spread naturally, owing to the fact that the female does not fly, and the fact that the larvae in its later stages descends from the trees and hides during the day-time, rendering it possible to trap it, greatly facilitate the work of destruction. On the other hand, the wide range of food plants, the extent of the area infested, including as it does large forests, and the ease with which the species may be artificially spread by means of vehicles, all combine to make the task a very great one. Still, if you would be provided with sufficient funds extending over a sufficiently long period, I believe these difficulties could be overcome.

But I feel that this is too much to hope. If at this time, so soon after the terrible ravages of the pest, the Legislature appropriates less than two-thirds of the sum which your committee, after

careful investigation, deems necessary to carry on the work, it is hardly probable that succeeding Legislatures would furnish the means necessary to carry this work to a conclusion. Involving as it would a large outlay for many years after the insect had ceased to be a pest. As I do not believe that the financial support would be furnished you, I respectfully suggest that you consider the advisability of adopting a different method of combating the pest. Much of the work that is being done now would be unnecessary if the object was merely to keep the insect from being unduly destructive; and, if there is no hope of your receiving the support necessary to exterminate the insect, the continuance of the present methods would certainly involve a large unnecessary expenditure.

It is probable that if your warfare against this insect was restricted to those localities in which its injuries are of a serious nature, its natural enemies would greatly increase and tend to keep it in check. Already a considerable number of parasites is known to infest it. There will be a tendency for them to increase, so that in time serious outbreaks of this pest will probably be only occasional and in limited areas. Such outbreaks could be easily subdued.

While I believe that a change in the object of the work of your committee seems imperative, I would not consider for a moment the giving up of your warfare against the pest, but would advise its continuance in the following manner: I would suggest no change in the organization for carrying on the entomological work of the State. A committee

of the State Board of Agriculture, constituted as is your committee, seems to me to be the most appropriate organization for this purpose. I would, therefore, recommend the broadening of the scope of the work of this committee, so that it should have authority to deal with any serious outbreak of insect pests. I will not presume to indicate in detail the method of conducting this work, beyond suggesting that in their more general features the horticultural laws of the State of California might serve as a model.

Very respectfully, your obedient servant,

J. H. Comstock

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Extract from the President's Address by L. O. Howard, Entomologist of the United States Department of Agriculture, delivered before the Sixth Annual Meeting of the Association of Economic Entomologists, Brooklyn, August 14, 1894.

The work upon the gypsy moth, by the way, which has been done by the State of Massachusetts since 1889, is one of the most remarkable pieces of work, judging by results, which has yet been done in economic entomology. The operations have been carried on by a committee of the State Board of Agriculture, and the means have been furnished by large annual appropriations by the State Legislature. Three hundred and twenty-five thousand dollars have already been appropriated.

A territory comprising something over one hundred square miles was infested by the insect, which occurred in such extraordinary numbers as to destroy many trees and almost to threaten the ultimate ex-

tinction of living vegetation, not only within the infested territory, but in all localities to which it might spread. It is unnecessary to detail the steps by which relief was brought about. Mistakes were undoubtedly made at first, and it is to the work of the present committee that the main credit is due. The infested territory has been reduced by one-half, and within the districts in which the gypsy moth at present exists it is, practically speaking, a comparatively rare species.

The future of the insect is, however, problematical. The continuance of sufficiently large appropriations from the State Legislature to enable the work to be carried on on its present scale is doubtful, and yet those in charge believe that still larger appropriations are necessary to bring about extermination. They are confident, however, that with sufficient means the insect can be absolutely exterminated from the State of Massachusetts. With the Legislature disinclined to continue the large appropriations, the methods of the committee at present pursued will have to be seriously altered. Given a small appropriation of say $25,000 annually, it will become necessary to adopt some law, like that enforced in California, whereby much less frequent inspection may be made, and the committee will have to rely in part upon voluntary observers for information, Moreover, they will be unable to conduct spraying operations upon a large scale, and the expense of the destruction of insects will have to be assessed upon the owners of the property upon which the insects are found, provided such owners will not themselves undertake the destruction of the

the case of unproductive lands the expense will be so great that the owner will prefer confiscation. Between some such course as this and the continuance of the present methods, however, there seems to be little choice, since if the appropriation were taken away, the insect will not only speedily reach its former destructive height, but will spread far and wide over the country.

It may be urged that it will be only a few years before the insect will take its place as a naturalized member of our fauna, and will become subject to the same variations of increase and decrease as our native species, and it will, in fact, become little more to be feared than species already existing with us, particularly if its European natural enemies are introduced. Against this view, however, it must be urged that the gypsy moth seems an exceptionally hardy species, and that even in Europe it is a prime pest. The caterpillar is tough and rugged, and seems little subject to disease and to climatic drawbacks, and is wonderfully resistant to the action of ordinary insecticides. The gypsy moth larva will feed for days without apparent injury upon trees which have been sprayed with Paris green or London purple in a solution so strong as to somewhat burn the leaves. In fact, the committee, in the spraying which they are carrying on at present, have found it necessary to use arsenate of lead in as strong proportion as ten pounds to ~~ma~~ one hundred and fifty gallons of water. The well-known vitality of previously introduced European injurious insects is apparently increased to a striking degree by this species, while the fact that it feeds on nearly all plants renders it a much more serious pest than any of its forerun-

ners. Under these circumstances, therefore, any course other than energetic and well-directed effort to keep the insect within its present boundaries will be short-sighted in the extreme, although it is very doubtful to my mind whether absolute extermination will or can ever be brought about.

PART II

Gypsy Moth and Brown-Tail Moth Work, 1900-1913

The gypsy moth law was not repealed but $18,000 was made available to May 1900 to close up the work. Between February 1 and April 30, 1900 this was done and equipment placed in the custody of an employee of the State Board of Agriculture for future disposal. An additional sum of $1,000 was made available for custodial purposes to cover the balance of the calendar year to January 1, 1901.

A part of the duties of the custodial employee was to note conditions in the infested territory, which covered an area the extreme limits of which aggregated 359 square miles, at the close of the field work in January 1900. The members of the Committee on the Gypsy Moth, Insects and Birds visited different localities throughout the year to observe conditions or confirm reports. During the summer it was found that the gypsy moth infestation had increased at some points within the known infested area and was beginning to attract attention and cause complaints in some centrally located towns where work could not be completed in 1899. Infestations were found which indicated that there had been some spread from previously infested locations.

In spite of this evidence that both the gypsy and the brown-tail moths were increasing the Massachusetts Legislature refused to appropriate funds to make the law effective during 1901 and owing to the danger of spread and possible future defoliation several towns and cities in the older infested area expended funds to abate the nuisance.

[illegible]

[illegible]

[illegible]

The Metropolitan Park Commission employed a considerable force of men to apply treatment throughout the summer of 1901 and some large property owners carried on active work.

Gypsy Moth Found in Rhode Island

July 31, 1901, Mr. Prescott D. Reynolds, an amateur entomologist, who was interested in butterflies and moths and frequently visited the Museum of Natural History at Roger Williams Park, discovered several adults and egg clusters of the gypsy moth on shade trees on Courtland Street in Providence, Rhode Island. The determination was confirmed by Mr. James M. Southwick, Curator of the Museum, and on account of the danger involved the specimens were immediately taken to the office of the State Board of Agriculture in Boston where the Secretary of the Massachusetts Board of Agriculture, Mr. J. W. Stockwell, and Mr. A. H. Kirkland confirmed the identification and accompanied him to Providence to visit the infestation. It was decided that the outbreak had been established for about two years and seemed to be confined to an areas of five to ten acres. They called upon the Acting Mayor and Mr. Southwick was authorized to spend $25.00 in further investigation. The services of Mr. F. H. Mosher, who had been engaged on gypsy moth work in Massachusetts, was secured to carry on further scouting work. One hundred dollars was appropriated for the purpose of examining the city of Providence. In all, five infestations were found in five different wards, and some treatment was applied. It was not until April 20, 1906, that the General Assembly passed an act, based on the Massachusetts law, providing for an appropriation of $5,100 for "Suppression and Extermination of the Gypsy and Brown-tail Moths" in

of the material arrived in living condition and that he hoped to continue in his attempt to establish these species.

Rhode Island and the appointment of a commission to carry on the work. Prof. A. E. Stene was appointed to the position of superintendent by the Governor.

In the 19th annual report of the Entomological Department of the New Hampshire Experiment Station summarizing insect conditions during 1901, the State Entomologist, Prof. C. M. Weed, called attention to the fact that the gypsy moth was increasing in Massachusetts and that the brown-tail moth had been found in Seabrook and Hampton, New Hampshire.

In his annual report for 1901 Dr. L. O. Howard, Entomologist, United States Department of Agriculture, pointed out that the discontinuance of the state work in Massachusetts offered an opportunity to introduce parasites of the gypsy moth. He reported that he had arranged with some of his correspondents in Europe to ship living Calosoma sycophanta and Calosoma inquisitor, two species of predaceous beetles for liberation in Massachusetts as enemies of the gypsy moth but none of the material arrived in living condition and that he hoped to continue in his attempt to establish these species.

In January 1902 the State Board of Agriculture made strong representations to the Massachusetts Legislature for funds to resume the work of extermination but no action was taken. In February a law was passed authorizing the municipal officer or officers to whom the care of shade trees in the streets or roads may be entrusted to apply reasonable measures to prevent the spread and to secure the extermination of the brown-tail moth, the elm leaf beetle or any other tree or shrub destroying pest, and to enter upon private land for the purpose of investigating these pests. The law provided that owners who have been damaged as a result of entry or clean up operations may secure

relief from the Court but any benefits received as the result of such entry shall be applied in reduction of such damage. It was also provided that whoever opposed entry or obstructed the performance of such local authorities should be punished by a fine not exceeding $20.00 for each offence.

In June an attempt was made to pass an amendment which would give these officials power to compel property owners to abate the nuisance under penalty but this amendment was not passed by the Legislature. Some communities continued their practice of the previous year of making money available for gypsy moth work which was expended by using methods which varied according to the ideas of the officials in charge. Some went as far as to pay school children to collect caterpillars of both the gypsy and the brown-tail moth at a stipulated price per quart. Other communities relied only upon the efforts of individuals which appeared to lack any uniform methods of treatment and the result was continued increase and spread of the pest. At this time it was estimated that the brown-tail moth occurred in the eastern part of Massachusetts and New Hampshire in an area of about 1,500 square miles and that the gypsy moth had spread beyond the most remote infestations known in 1899.

It appeared to some that the opportunity of exterminating the gypsy moth had been lost and that the problem could be approached only by an attempt to control the pest and prevent its further spread. The annual report made by the Committee on theGypsy Moth, Insects and Birds of the Massachusetts Board of Agriculture to the Legislature emphasized "the futility of individual efforts in controlling the moth and the present pressing need for thoroughgoing, concerted, systematic work against the pest over the whole infested district."

In 1903 Mayor Charles L. Dean of Malden Petitioned the Legislature for an appropriation of $100,000 to enable the Massachusetts Board of Agriculture "to prevent the further spread of the brown-tail moth, the gypsy moth and other destructive insects." Later a bill was introduced to appropriate $250,000 to be expended in three years conditioned on a certain percentage of this amount being refunded by cities and towns where work was done. Opposition developed to retaining the management of the work with the Massachusetts Board of Agriculture and it was defeated. Work on these pests was left with the local officials and the individual owners of property.

The annual report of the Committee on the Gypsy Moth, Insects and Birds of the Massachusetts Board of Agriculture in 1903 indicated a continuous increase in the abundance of the gypsy moth although weather conditions did not seem unusually favorable for its increase, and Professor C. H. Fernald reported that the moth "has now to a considerable extent recovered from the attacks made upon it by the State, which ceased in 1899, and in many places is as abundant as it ever was." He further stated "this probably settles the possibility of extermination in the negative for the future. The State has lost its opportunity and must abide by the results. No new parasites or predaceous foes have appeared thus far and man must depend almost entirely on his own exertions to control this pest."

The brown-tail moth was found in Portsmouth, New Hampshire, for the first time as well as in several towns as far west as Worcester and Westminster, Massachusetts.

During the 1904 session of the Massachusetts Legislature eight bills were offered by petition for resumption of the gypsy moth work requesting appropriations ranging from $75,000 to $300,000 for three

years and to $150,000 for one year, and providing varying methods of attack under the direction of the Massachusetts Board of Agriculture from extermination under the plan followed previous to 1900 to one for suppression and prevention of spread through cooperation with infested cities and towns. None of these bills received favorable consideration.

In January 1904 Congressman Gillett of Massachusetts offered an amendment to the Mexican boll weevil appropriation of $250,000 which was pending in Congress for an additional $250,000 for extermination of the gypsy moth. This amendment was ruled out of order, however, and no favorable action was taken.

During this summer the brown-tail moth received extraordinary public attention when great flights of moths were observed in many sections, and many complaints were published concerning the poisoning effects of contact with different stages of this pest. Continued extension of the brown-tail moth infested area was reported, the general spread being in a northerly direction, so that distribution in 1904 covered most of southern New Hampshire, southwestern Maine, as well as the northeastern countries of Massachusetts previously infested.

Efforts toward abating the nuisances of both insects were continued by local authorities who furnished advice to property owners, but the lack of a systematic plan of work under experienced supervision failed to accomplish results.

Although wider and more influential interest was aroused, proponents of systematic measures were not agreed on a plan of work and the time passed until it was too late for action before the caterpillars had despoiled much larger areas than in any previous years. Dr.

C. L. Marlatt, then in charge of experimental field work for the United States Bureau of Entomology, was instructed to investigate the status of the gypsy moth and the brown-tail moth by the Secretary of Agriculture, at the instance of Congressman E. W. Roberts and Mr. J. L. Ellsworth, Secretary of the Massachusetts Board of Agriculture. Dr. Marlatt had visited the infested area in 1902 and his observations then "Scarcely prepared" him for the conditions found in July of 1904. He wrote in his report, published as Circular No. 58 by the Bureau of Entomology, as follows:

".....a condition of infestation and defoliation or stripping was found which the writer had never before seen in the gypsy moth region, and which was undoubtedly many times greater than in the worst of the earlier years of gypsy moth damage."

He found very little spread beyond the area previously infested by the gypsy moth but believed "its excessvie multiplication of the summer of 1904 will probably lead to considerable extension of its range."

Inquiry indicated the cost of applying remedies for local gypsy moth control during the past year, by tree wardens, local officials and by citizens, many of whom employed contractors, approached $200,000 which was equal to the largest sum spent by the State in any single year when the extermination work was keeping the insect reduced so that its presence was noticeable in only a very few localities. Much of the infested area received no treatment whatever which resulted in nullifying the treatment applied by interested owners for their own protection and made possible the opportunity for continuous spread of the pest. (Plates XX and XXa) Many areas were visited where com-

plete extermination was accomplished by the Board of Agriculture prior to 1900 while many others where the work of the Board had not been completed were reinfested and were furnishing centers for spread to surrounding territory.

He visited the infested areas in the city of Providence, Rhode Island, and stressed the necessity of preventing spread to outlying areas by enforcement of regulations to restrict carriage of the pest.

He commented favorably on the effective work that had been done by the Massachusetts Metropolitan Park Commission in some of the infested woodland reservations and indicated that the problem was serious and its effective management was urgent. He expressed the opinion that some system would be devised so that the cost of control would be divided between the individual owner, the town, and the State or National Government, should national aid be granted, the idea being that this would stimulate interest in the problem and insure a sustained effort.

1905

The visit of Dr. C. L. Marlatt in the summer of 1904 to the gypsy moth infested area in Massachusetts, the report of his findings relative to the seriousness of the problem and the recommendations which he made focused attention on finding some means to control the ravages that were resulting from these pests.

A little later in the year several local improvement and anti-moth socities were organized and combined into the Massachusetts Association for the Suppression of the Gypsy and Brown-Tail Moths under the presidency of Hon. George R. Jones of Melrose who was recently president of the Massachusetts Senate. Cooperation was secured with

the State Board of Agriculture, the Massachusetts Forestry Association and other interested organizations and citizens and a strong effort was made to harmonize many conflicting views concerning the best method of approaching the problem. This finally resulted in the presentation of a bill to the Legislature to provide for the suppression of these pests. After various amendments had been made this bill was passed and signed by Gov. William L. Douglas on May 8, 1905. (See Appendix C) (See page 158) Briefly it set up three organizations, State, local and individual, so that the responsibility, management, and execution of the work and the liability for expense would be distributed between these three groups. The State organization was to develop and supervise systematic work in each city and town, to assist in a campaign of education relative to controlling the moths and by means of trained employees make thorough examinations in the infested territory and assist in developing and training local organizations to a maximum degree of efficiency. The local organization in each municipality was required to enforce the law on private and public property. Within definite limits of expense, the individual was required to destroy the moths on his property under prescribed penalities for neglect. The general plan seemed feasible but its success required the intelligent and hearty cooperation of all parties. The following summary which is quoted from the first annual report of the Massachusetts superintendent indicates the essential features of the act.

"The Moths are Public Nuisances."

The gypsy and brown-tail moths are declared public nuisances and their suppression is required.

The Superintendent of Suppression.

A superintendent appointed by the Governor, with power, subject to the Governor's approval, of appointing agents and assistants, has entire general charge of the work of suppressing the moths.

Duties of Cities, Towns and Individuals.

Cities and towns (under the advice and general direction of the superintendent, and by such agent as they may designate or appoint) are required, under penalty of neglect, to destroy the eggs, pupae and nests of the gypsy and the brown--tail moths within their limits, excepting that such work is not to be done by cities and towns on property controlled by the Commonwealth; nor is it to be done upon private property excepting where the owners of the same fail to destroy the eggs, pupae and nests of the moths, in accordance with the terms of the official notice to private owners, noted in the section here following:--

Notice to Private Owners.

The mayor of every city and the selectmen of every town shall, at suitable times, notify every owner of land located therein which is infested with the moths, requiring him to destroy the eggs, pupae and nests of the moths within a specified time.

When the mayor or selectmen decide that the cost of such destruction (on lands contiguous and under one ownership) will exceed one-half of one per cent of the assessed valuation of the lands, then they may designate in the notice a part only of such lands on which the destruction shall take place.

Failure of Private Owners to destroy Moths.

If the owner does not, as required by the terms of the aforesaid notice, destroy the eggs, pupae and nests of the moths, then the city

or town, subject to the approval of the State superintendent, shall destroy them, and shall assess upon such aforesaid lands the actual cost of so doing, to an amount, however, not exceeding one-half of one per cent. of the assessed valuation of the land.

This amount, so assessed, shall be collected in the form of taxes, and constitutes a lien upon such lands.

Redress by Abatement and Appeal.

The assessors may abate the moth assessment in the case of any private land owner decided by them to be unable to pay it because of age, infirmity or proverty.

Appeal to the county superior court, with special provision for prompt hearing, is provided by the statute for any person aggrieved by assessment on account of this work; provided a complaint is entered within thirty days of notice of such assessment.

Appropriation by the Commonwealth.

To meet the expenses incurred under its moth-suppression law, the Commonwealth has appropriated $300,000. Of this sum, $75,000 may be expended during 1905, $150,000 (and any unexpended balance) during 1906, and $75,000 (and any unexpended balance) during 1907, up to May 1, 1907, inclusive.

For the purpose of experimenting with natural enemies for destroying the moths $10,000 is additionally appropriated for each of the years 1905, 1906, and 1907.

Reimbursements to Cities and Towns

1. Cities and towns with valuation of real and personal estate of $12,500,000 or more having spent $5,000 in any one calendar year,

shall be reimbursed annually fifty percent (one-half) of all further expenditure.

2. Cities and towns with valuation less than $12,500,000 and more than $6,000, having spent an amount equal to one-twenty-fifth of one per cent of such valuation in one year, shall be reimbursed annually eighty percent (four-fifths) of all further expenditure.

3. Towns with valuation less than $6,000,000, having spent an amount equal to one-twenty--fifth of one per cent of such valuation in one year, shall be reimbursed once in sixty days for all further expenditure.

Limits to required expenditure by Cities and Towns.

No city or town with an assessed real and personal valuation of more than $6,000,000 shall be required to expend in the suppression of the moths, during any one full year, more than one-fifteenth of one per cent of such valuation. No town with an assessed real and personal valuation ofless than $6,000,000 shall be required to thus expend during any one full year more than one-twenty-fifth of one per cent of such valuation.

Valuations of 1904 taken as Basis.

Wherever valuations of real and personal property are referred to in the gypsy and brown-tail moth suppression law, the valuations of 1904 are meant.

Wilful Resistance or Obstruction.

Wilful resistance to or obstruction of any agent of the Commonwealth or of any city or town, while lawfully engaged in the execution of the purposes of the moth-suppression law, is forbidden under penalty."

On May 8 Mr. A. H. Kirkland was requested to confer with Governor Douglas with reference to the position of superintendent for suppressing gypsy and brown-tail moths, and the appointment was tendered to him on May 10. He was released from his service with the company by whom he was employed and qualified for the position on May 15. It was a source of general satisfaction that he had been appointed to this position because his training and experience on gypsy moth work made him eminently fitted to supervise this important and difficult assignment.

He established an office in Boston on May 16, organized an office and field force and developed the necessary system of bookkeeping and reports without delay. Mr. J. A. Farley who had previously been associated with the gypsy moth work which was conducted by the Committee on the Gypsy Moth, Insects and Birds of the Board of Agriculture and Biological Survey was selected as his secretary. In assembling the field staff Mr. D. M. Rogers was appointed assistant superintendent and field agents were selected as follows: F. A. Bates, Southern Division, J. W. Enright, Northern Division, C. W. Minott, Western Division and L. H. Worthley, Eastern Division. All of these men had had extended experience on gypsy moth work and were competent to handle the territory in their division.

During May and June conferences were held nightly with city and town boards in organizing local work to meet the requirements of the new law. It was necessary to obtain an accurate knowledge of the extent of the infested area and to organize active work in the cities and towns where the insect was known to occur as no equitable apportionment of the State appropriation could be made until this information was available. The policy was adopted in organizing the field work to employ men of

experience and proven ability in work against these pests and this policy resulted in quickly assembling an efficient organization. As a result of this work the outer edge of the infested region was determined in the fall of 1905 and outside this area a belt of towns was examined where no gypsy moths were found. The following table indicates the number of cities and towns and area in square miles where the gypsy moth was found at the close of the calendar year 1899 when the original gypsy moth work was concluded in comparison with the conditions found in 1905:

Year	No. of Towns and Cities	Area in Square Miles
1899	34	359
1905	124	2,224

The accompanying map shows the area over which gypsy moth operations were necessary. (Plate XXI)

Owing to the late date of the passage of the new law and the extensive task of organizing the work it was not possible to cover or treat extensive areas during the summer. Considerable progress was made, however, on street trees and in residential areas in the central infested area so that the increase of the insect was retarded. Little work was done in the great bulk of the known infested towns as sufficient time was not available. In effect the work accomplished over the immense area was only preliminary to a long sustained effort.

The brown-tail moth was found throughout the area in varying numbers, principally north of Boston, the spread having extended along the seacoast and in cities and towns. (Plate XXII)

Work was carried on at Providence, Rhode Island and in New Hampshire by the State authorities and it was determined that energetic

measures would be necessary in both of these States if serious damage by the gypsy moth was to be prevented. In New Hampshire infestations were found within a few weeks along the coast line towns from the Massachusetts border beginning at Seabrook and extending to Portsmouth. No gypsy moths were found in Maine or Connecticut.

The Brown-Tail Moth

Inasmuch as the Massachusetts law provided for work on the brown-tail moth with the same organization as was set up for gypsy moth control it was necessary to organize similar work in the towns found to be infested by the former insect, the methods being modified to conform to its habits. As the result of examination of territory and cooperative work which was done by entomologists in the adjoining States the brown-tail moth was found in Providence, Rhode Island and in the two southern tiers of counties in New Hampshire and a single specimen was received from the White Mountain region by Professor E. D. Sanderson, the Entomologist of the Agricultural Experiment Station. In the summer notable flights of the moths were observed in Nashua, Concord and Portsmouth. In Maine the State Entomologist found the pest along the seacoast towns. Portland, Rockland and Augusta were generally infested while a sufficient number were discovered at Bar Harbor to warrant local work. Moths were also reported at Eastport, Maine and St. John, New Brunswick.

During the period since the insect was first discovered in Somerville, Massachusetts, it had become established along the eastern seaboard of New England and westward to central Massachusetts and southern New Hampshire, and the islands of Martha's Vineyard and Nantucket

had not escaped infestation. The insect was not found by the State Entomologist in Connecticut.

Owing to the widespread distribution of the insect which was made possible principally by the ability of both sexes of the moth to fly freely, particularly along the course of the prevailing winds in midsummer and its great attraction to bright lights at night, the eradication of the insect based on the knowledge available at that time of the territory which it occupied and other factors concerning its habits made it unwise to attempt complete extermination of the species. On account of the poisoning which resulted to human beings by coming in contact with the hairs of this insect repressive measures were undertaken in order to make badly infested areas livable during the warm weather. As a result of this much local work was done by property owners and local civic organizations in order to abate the nuisance, as it was hardly possible during the year to secure additional funds from Massachusetts cities and towns where appropriations had been made for gypsy moth control to comply with the new law. Early in the work on account of the large territory involved there developed a tendency in some localities to bring this work under local political control and it required constant effort by the State office to keep its operations on a merit basis so that a maximum amount of value could be received by the towns which were appropriating funds for the relief of citizens and visitors and for the protection of the tree growth concerned.

Organization of Town Work in Massachusetts

The local appropriations were as a whole freely made and before the close of the year 95 cities and towns of a total of 124 infested

with the gypsy moth had a more or less complete organization and upwards of 1,500 men were employed on this work. Great credit is due the superintendent, field agents and assistants for the initial work of starting this project in a limited time under conditions of heavy infestations which required immediate attention.

Policy Adopted Relative to Treatment for the Gypsy Moth and Brown-Tail Moth

Inasmuch as the habits of these insects differ, methods had to be used for their control and extermination which would be most effective and the following points were considered in this respect:

"(1) The gypsy moth spread slowly, almost entirely by agencies of travel. The female moth does not fly. The brown-tail moth is a strong flyer and is borne by the wind for many miles.

"(2) The gypsy moth is a serious pest of all trees, both deciduous and confierous, and attacks all shrubs and sometines even crops. The brown-tail moth attacks deciduous trees and is mainly a pest to fruit trees and oaks.

"(3) The gypsy moth is often hard to find even when abundant and its treatment calls for a high degree of skill as well as a liberal outlay of money. The brown-tail moth is easily found in winter when its webs are prominent at the tips of the twigs. Its destruction is relatively inexpensive and calls for no particular skill.

"(4) But few gypsy moths are likely to reach Massachusetts from small colonies outside the State."

On the basis of these facts it seemed unwise to authorize large expenditures of money to combat the brown-tail moth in woodlands while in the case of the gypsy moth every possible effort was necessary in

order to stamp it out wherever it occurred. It was decided to urge local superintendents of the necessity of destroying the brown-tail moth on street trees and that every property owner destroy the pest on his home grounds and in his orchards. In this way street trees are protected from injury by caterpillars and the danger of caterpillar poisoning is eliminated for the next season.

The same idea was followed in connection with the gypsy moth work on shade trees and on private estates to make a special effort to protect all roadside trees where heavy infestation existed whether in the centers of population or in outlying country to prevent spread of the caterpillars by travel. This made it necessary in many towns particularly where gypsy moth infestation occurred in woodlands adjoining travelled roads to pay special attention to keeping the roadways free from infestation and this was followed up by clearing and treating safety zones 50 to 100 feet in width along such roadways and in parks and playgrounds and to carry on as much work as possible in centers of heavy infestation in woodland areas.

The work on the gypsy moth and the brown-tail moth are dissimilar in some respects and an effort was made to separate as far as possible the expenditures for each type of work in the cities and towns. A detailed statement of the condition of each town will be found in the annual report of the State Superintendent for the year 1905 and similar reports were made in the years which followed.

The superintendent was fortunate in securing the cooperation of the Massachusetts Board of Agriculture and other organizations as well as of various State and mumicipal commissions who controlled

large areas of land which were used for recreational or public service purposes. Among them may be mentioned the Metropolitan Park Commission, Metropolitan Water and Sewage Board and the Massachusetts Highway Commission, several State hospitals and State parks as well as a number of United States Reservations. A considerable number of citizens who owned large estates and were interested in the problem carried on large field operations at their own expense in order to give material assistance in bringing the pest under control. The State Entomologists in adjoining States where slight infestation had been found or whose territory was particularly threatened carried on a limited amount of work and maintained a lively interest in protecting their own territory and cooperating with the superintendent in Massachusetts. The latter arranged for the services of Prof. C. H. Fernald as consulting entomologist who reported from time to time on the condition of the work and the broad aspects of policy which were of special importance in conducting the field and experimental activities.

Contract Work

As a result of the tremendous increase in the gypsy moth and brown-tail moth and the passage of the law to set up an organization for systematic control work, particularly because the underlying principle was based on the requirement that each property owner was responsible within certain financial limits to care for his own property, there arose a great demand for competent men to handle gypsy moth work for individuals. This resulted in a large amount of work being done under contract and there developed many difficulties relative to the failure of some contractors to do the work in a

manner which was acceptable to the supervising office. This caused much criticism and it was necessary for the superintendent to maintain a list of contractors who by their records of reliable and efficient service could be referred to citizens desiring work of this type. In this way many inefficient and unreliable contractors were eliminated, the gypsy moth service improved and a better grade of work was furnished to individuals desiring it.

National Aid

Inasmuch as the control of the gypsy moth and the brown-tail moth was no longer confined to a single State the problem of national support on an interstate basis furnished an additional reason why the Federal Government should assist in the undertaking and appropriate funds to prevent the nation-wide spread of these insects. In spite of the fact that every attempt that had been made in the past for Federal assistance had failed sentiment strongly favored the assumption by the Federal Government of a portion of the burden at least.

Importation of Natural Enemies

In addition to the funds appropriated for direct control work in Massachusetts an appropriation was made of $10,000 a year for three years for the investigation and importation of parasites and other natural enemies of these moths. Following his appointment as superintendent and with the approval of the Governor, Mr. Kirkland went to Washington and arranged with the Secretary of Agriculture, Hon. James Wilson, relative to Federal cooperation in connection with

the work on natural enemies. By this arrangement the general management of this work was placed in charge of Dr. L. W. Howard, Chief of the Bureau of Entomology and State funds were placed at his disposal. This was a particularly fortunate arrangement because the Federal funds available at that time were insufficient to adequately finance a project of this sort. Dr. Howard's long experience and specialized knowledge of parasite work together with his intimate acquaintance with the leading entomologists throughout the world enabled him to make immediate contacts so that the work could be started with a minimum amount of delay.

Great stimulation was given to this work by a visit of Dr. Howard during the summer of 1905 to many European countries, the expense of which was defrayed by a Federal appropriation of $2,500 for gypsy moth and brown-tail moth parasite investigations, where he secured cooperation with leading entomologists and by arrangements which he made for the employment of experienced foreign collectors to obtain and ship parasitized material to Massachusetts. Arrangements were made for Professor A. J. Cook, Professor of Entomology at Pomona College, California and later Horticultural Commissioner of that State, who was at the time in Berlin, to cooperate and forward as much material as possible. During the year material was received from Japan, Austria, Germany, Switzerland and Italy.

In the meantime a small building was secured for temporary laboratory purposes which was replaced later in the season by a larger building at North Saugus, Massachusetts. Mr. F. H. Mosher, a well trained entomologist with long previous experience on the gypsy moth work, together with Mr. E. A. Back and Mr. O. L. Clark, who at that time were students at the Massachusetts Agricultural College, carried on special-

ized work during the summer in handling imported material and making observations on natural enemies of the gypsy moth including parasites, predators and diseases that might have built up in the field during the lapse of intensive field work. (Plates XXIII and XXIIIa)

In June 1950 a number of reports were received indicating that brown-tail moth larvae were found in Wakefield, Massachusetts by Field Agent J. W. Enright, which appeared to have been killed by a fungous disease. Dr. George E. Stone, Botanist of the Massachusetts Agricultural College, was consulted, also Professor W. G. Farlow of Harvard University who determined the disease as Empusa aulicae, Reichardt. As a result experimental work was conducted at the laboratory and some progress made relative to the nature and behavior of the disease which appeared to be similar to a species which had previously been reported in Europe and America by Dr. Roland Thaxter as attacking insect larvae and grasshoppers.

The underlying principles which were followed in the importation of parasites had to be based fundamentally on specific knowledge of the insects which were positive enemies of the gypsy moth and the brown tail moth in their native homes as there had been few species indigenous to the United States which had developed on these hosts over a large area during the period that experimental work had been carried on in this country. As immediate action seemed to be desirable owing to the tremendous infestation which occurred in Massachusetts the following procedure was adopted:

"1. To collect in Europe a large quantity of parasites and parasitized nests, caterpillars and pupae of the moths.

"2. To pack safely and ship them so that they may arrive with the

least possible delay.

"3. To care for the material in such a way that as many parasites as possible may be obtained.

"4. Most important of all to detect and kill every single form of injurious secondary parasite.

"5. To propagate the true parasites under the most favorable conditions.

"6. To finally liberate in the field large numbers of these parasites in close proximity to the caterpillars which are their natural hosts."

This made it necessary for trained and expert specialists to eventually handle this work, although the material which was received during the first year and which survived shipment in living condition at a time of year when they could be advantageously studied was very small. The work for 1905 was largely of a preliminary nature and established a ground work for future investigations.

The first annual report of the superintendent recommended a number of amendments to the gypsy moth law which were designed to make the work more effective. Most of these were to clear up technicalities but it was also recommended that field employees be placed under Civil Service and a practical, competitive examination be required which would include the possession of good eyesight and physical ability and skill in climbing trees, and that additional funds be provided to meet the cost of enlarging the work which would be commensurate with the increased area that was determined during 1905.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1906

The year 1906 marked the first full year of accomplishment in the

suppression of the gypsy moth and the brown-tail moth under the Massachusetts program providing for organized cooperation between the State, the infested cities and towns, and private individuals. In addition to the appropriation of $150,000 set up in the Act of 1905 the sum of $75,000 was made available this year which made it possible to increase the reimbursable work done by the several cities and towns, and which, in turn, was found to be very effective in reducing many of the heavy infestations along the roadsides and in adjacent woodlands.

Continued efforts were made to perfect the municipal organizations and assist in creating new organizations in those towns which were not in operation. This phase of management by the state superintendent was most important since success or failure of the entire program depended largely upon the attitude of the citizens and the efficiency of the local superintendents. This attitude determined the amount of funds provided by each municipality and the efficiency of the local superintendents determined the value received for the money expended. Some apathy and slight opposition toward compliance with the requirements of the law was met with on the part of a few cities and by many owners of private estates. Continued pressure and education went a long way toward rectifying this situation, but whole-harted cooperation was the general rule and indifference the exception.

The superintendent has reported in detail the work in each city and town for the year in his second annual report, published in January 1907. In summary, he has noted that over 8,000 miles of streets and roads, where danger of spread by passing travel was greatest, were cleared of moths by thinning, cutting out, and burning brush and worthless trees where the pest was harbored, then this was followed by burlapping and spraying where it was most needed. In many

areas infested woodland abutting the travelled roads was treated to create a cleaned belt back from the road for fifty to one hundred feet. The work of clearing brush and woods on private estates was completed for the year on May 1, but many were neglected by the owners and remained a dangerous source of reinfestation of neighboring estates.

During the caterpillar season, in conjunction with spraying, burlap or tanglefoot bands were applied to trees and were tended during July and August. Over 1200 men were engaged in this work, in addition to the assistance of thousands of property owners. After the caterpillar season had ended a large amount of creosoting of egg clusters was done, emphasis being placed on killing the eggs laid from the ground up to the probable snow level. The number of employees had varied from 1200 down to about 250 when this part of the plan was completed on October 1. Cleaning and thinning work in the more heavily infested woodland colonies in the central towns occupied the month of October until November 1 when the intensive winter cleaning and creosoting of street trees began. On December 31, 1906, about one thousand men were at work and this figure does not include the men employed by the Federal Department of Agriculture, the Metropolitan Park Commission, other State Boards, and Gen. S. C. Lawrence.

The actual definite limits of the infested area remained undetermined, even though a rough idea was given by the scouting during 1905. Further scouting was continued, both within and contiguous to the known infested towns but a force large enough to do a thorough job could not be spared since it seemed a better policy to use all available man power for reduction of the badly infested sections first. The few small scouting crews detailed to inspect the outlying

area discovered the gypsy moth had invaded several localities found free in 1905, including part of Cape Cod, which increased the number of known infested towns in Massachusetts from 124 to 140, and the infested area from 2,224 square miles in 1905 to 2,583 square miles in 1906. It was not assumed the limits were reached and discovery of small infestations further distant appeared possible. Because of its strategic position, Worcester, situated on a high elevation and a center of heavy traffic, was scouted by a special force in September but no infestation was found.

In general, some progress was reported in abating the nuisances of the gypsy moth in the residential districts. Several representative citizens living in the most heavily infested sections attested to the fact that conditions were noticeably improved. However, the woodlands presented a discouraging picture, the colonies were plentiful and generally distributed throughout the entire area, and particularly in the central towns where a large degree of stripping occurred. Important infestations remained, in a ring around the central towns, where only preliminary treatment was possible.

The area in Massachusetts infested by the brown-tail moth apparently remained the same as reported in 1905, and the degree of infestation showed no apparent increase, probably due principally to a marked epidemic of disease. This disease, an interesting fungus, was noted in 1905 to be very effective in destroying the insects in wholesale numbers in certain localities. The disease persisted through the winter on the caterpillars in the hibernating webs and was an important factor in reducing the pest in many woodlands. On the other hand, in spite of the disease, certain sections of Boston and Lowell suffered severe annoyance when the caterpillars emerged in

the spring. Many caterpillars were destroyed by the fungus in the summer of 1906, but the presence of the disease on the winter webs in the fall was not so conspicuous as in the previous fall.

An investigation was made, also, of the cause of the brown-tail poisoning by Dr. E. E. Tyzzer, pathologist of Harvard University. Dr. Tyzzer showed that in addition to mechanical irritation caused by the hairs that actual poisoning was caused by a toxin contained in the short "nettling hairs", which works easily recognized changes in the blood and will spread the resultant rash to other parts of the body from any single point of infection. (Plate XXIV)

The prevalence of the brown-tail itch brought into the market a large number of remedies designed to lessen its extreme annoyance and discomfort. Some of the remedies possessed merit for external application, of which the most effective was a prescription used with favor at the laboratory: carbolic acid, 1/2 drachm; zinc oxide, 1/2 ounce; lime water, 8 ounces; thoroughly shaken, and rubbed well into the affected parts.

National Aid

On December 4, 1905, the Hon. Ernest W. Roberts, Congressman from the Seventh Massachusetts District, presented two bills to the Congress, one carrying an appropriation of $250,000 for the purpose of exterminating or controlling the gypsy moth and the brown-tail moth, the other of $15,000 for investigation and importation of their natural enemies from foreign countries, both appropriations to be expended under the direction of the Secretary of Agriculture.

On February 13, 1906, Prof. C. H. Fernald, Gen. F. H. Appleton, W. H. Bowker and State Superintendent Kirkland, at the direction of Governor Douglas, appeared before the House Committee on Agriculture on behalf of the bills presented by Congressman Roberts. Also present were the Hon. Frederick H. Gillett, Hon. Butler Ames, Hon. S. W. McCall, Hon. John W. Weeks, Hon. W. S. Greene, all members of the Congress from Massachusetts, Director H. J. Wheeler of the Rhode Island Experiment Station and Prof. E. F. Hitchings, State Entomologist of Maine. Largely as a result of the endeavors of these men in presenting the situation, Congress passed an appropriation of $82,500 to be used in preventing the spread of the moths in New England, which became available on July 1, 1906.

The Federal work was promptly organized by Dr. L. O. Howard, Chief of the Bureau of Entomology, and Mr. Dexter M. Rogers, assistant to Mr. Kirkland in the Massachusetts work, was released from the State work, and was placed in active charge of the field work. Since the Federal effort was designed to prevent the spread of the moths, Mr. Rogers' first steps were taken to clear infestations along the main highways. The first season a program of thinning trees in the infested area in a protective belt 100 feet wide along 25 to 30 miles of highway was accomplished.

Work of State Boards

The Metropolitan Park Commission, the Metropolitan Water and Sewerage Board, and the Massachusetts Highway Commission held lands in the infested district and cooperated hartily in the efforts to suppress the moths.

Employees of the Metropolitan Park Commission worked on all the parkways and reservations, in the Middlesex Fells which was most heavily infested, while the Blue Hills Reservation work was done by contract. A considerable amount of thinning and burning was accomplished in the Fells, resulting not only in a reduction of the trees to be cared for but, also, an improvement in the forestation of the reservation. Creosoting of clusters was here carried out along the roadsides in a strip from 200 to 500 feet wide. As a result, no conifers were defoliated, the borders of the roads remained free from defoliation, and the infestation was greatly checked.

The Metropolitan Water and Sewerage Board reported that the greater portion of their work was done on the land surrounding Spot Pond, although considerable effort was placed on cleaning up infestations around the Chestnut Hill Reservoir and along the aqueduct lines in Newton, Weston and Wellesley. Nests of the brown-tail moth were found and destroyed on these lands, and in addition, around the Sudbury Reservoir in Marlborough, Southborough and Framingham, around Lake Cochituate, and on the grounds around the Wachuset Dam in Clinton. Around Spot Pond 25 men were engaged in treating egg clusters, thinning trees and underbrush on 50 acres, and during May to early July an area of 110 acres was sprayed. Windrows of oiled hay were placed along the edge of property owned by the city of Medford where a heavy migration threatened the adjacent Spot Pond property but this method proved less efficient than a barrier of 10 inch boards set on edge and coated with tanglefoot. Egg clusters were destroyed and trees sprayed at Mystic Lake and at the Chestnut Hill Reservoir. A total amount of $12,700 was expended during the year, of which about $10,500 was spent on

lands around Spot Pond.

The Massachusetts Highway Commission work was done mostly by local men, in each town through which State highways passed, although a considerable amount was done by contractors, under direction of the State superintendent. Expenditures amounted to $7,337.07 for the year. Work was confined to the trees and brush within the highway limits.

Particular reference is made to the work ofGen. Samuel C. Lawrence of Medford, which is a conspicuous example of what a public-spirited citizen has done in combatting these pests. During 1906 Gen. Lawrence took care of public and private land at his own expense covering an area of 1,441 acres, or 2¼ square miles of badly infested territory. This area included large sections in the city of Medford woodlands, also in Winchester and in the Middlesex Fells. He used tree protectors, burlap and tanglefoot on thousands of trees, thinned cut and cut underbrush, and, in addition to spraying 327 acres of infested forest in the Middlesex Fells and 145 acres of woodland owned by the city of Medford, creosoted gypsy moth egg clusters and destroyed webs of the brown-tail moth throughout the entire territory mentioned and on his own property.

PARASITE WORK

The effort to import parasites was carried on this year with added vigor, due in no small part to the direction of the work by Dr. L. O. Howard, and by the results of his second trip to Europe in the interests of perfecting the organization of the corps of European collectors, which enlisted on the laboratory staff nearly every economic entomologist of note in the moth-infested districts of Europe. This year Dr. Howard detailed Mr. E. S. G. Titus from the Bureau office in Washington for seasonal work on the parasite problem in Massachusetts who with Mr. F.

H. Mosher of the State staff, had direct charge of the imported material and dissemination of the parasites.

A total of 117,237 brown-tail webs were collected in Europe and imported to the Massachusetts laboratory, from which 64,000 primary parasites were obtained, and five plantings of 10,000 each were made in the field. In addition 37,729 gypsy moth caterpillars and pupae were received from which 1,538 primary parasites emerged, and 36,191 brown-tail moth caterpillars and pupae yielded 1,104 parasites. Of these 2,000 Tachinid flies were liberated in the field. Six hundred and ninety living Calosoma sycophanta were received, 360 of which were liberated and 172 Calosoma inquisitor, of which 110 were liberated. Recoveries of the Calosoma beetles were found in the fall, indicating success for their establishment. Confident hope of similar success was expressed for the establishment of Pteromalus processionae and Pimpla examinator, which were the most numerous of the parasites obtained from the imported material. Parasites of the genus Apanteles appeared promising but they had not yet been reared in any great number from the material received.

Federal and Other State Gypsy Moth and Brown-tail Moth Work - 1906

The details of the successful effort to interest the Federal Government in the control and prevention of spread of the gypsy moth and the brown-tail moth, which culminated in appropriation by the Congress of $82,500, are given in the summary of the Massachusetts work for 1906. These funds were appropriated to enable the Secretary of Agriculture to meet the emergency caused by the continued spread of the gypsy moth and which had become an interstate problem. Mr. Harry W. Vinton, who had served many years on gypsy moth field work,

was selected as field assistant to Mr. Rogers and directed the field crews who were employed to clear up dangerously infested areas along trunk line roads after the beginning of the fiscal year, July 1.

The necessity for immediate Federal action on an interstate basis was forcibly demonstrated by the report, in March 1906, from Dr. W. E. Britton, State Entomologist of Connecticut, that several egg clusters of the gypsy moth had been discovered in Stonington in that State. The gypsy moth had been found in New Hampshire towns along the coast from Seabrook to Portsmouth in 1905, and in Providence, Rhode Island in 1901. Late in 1906 scouts were sent into Maine from the Federal office and in November egg clusters of the gypsy moth were found in coast towns from Kittery to Kennebunkport. A single egg cluster was found at the National Soldiers' home in Togus, which was 81 miles from the nearest known infestation, and which was doubtless the result of accidental transportation of the insect by an inmate or a visitor to the grounds from the infested territory. This infestation was promptly exterminated.

The greater part of the Federal work for the year was undertaken in Massachusetts where emphasis was placed on the program of preventing spread of the gypsy moth by clearing or thinning and treating protective belts along the roadsides, most particularly along the heavily infested sections of the highways of main travel leading from the infested territory. These protective belts or strips averaged 100 feet wide on each side of the highway and, while the first year's work was more a preliminary measure for future economical treatment, once cleared of the gypsy moth and kept cleared, one dangerous source of spread, by carriage, would be eliminated.

Approximately 30 miles of woodland roadside was thus prepared in 1906, and this was performed in cooperation with and in addition to the work undertaken by the Massachusetts State organization which concentrated its endeavors in the more heavily infested residential areas. No distinct Federal brown-tail moth control work was done in Massachusetts excepting that webs found in the course of the roadside gypsy moth work were cut and destroyed.

No State funds were available for moth work in New Hampshire in 1906, although several infestations had been found there in 1905, as noted above. The brown-tail moth had become thoroughly established throughout southern New Hampshire and great injury had been caused to many orchard, shade and forest trees. Federal assistance was requested early in July, too late for any effective work against the caterpillars and scouting was deferred until fall when an examination revealed the presence of the moth in 36 municipalities in the southeastern part of the State. including Nashua, Manchester, Dover and towns to the east.

A similar situation existed in Maine, where the only work possible considering the funds available and the lateness of the season, was a limited amount of scouting which resulted in the discovery and treatment of the infestations mentioned above. No Federal work against the brown-tail moth was performed but a State appropriation of $5,000 was used for this purpose under the direction of Prof. E. F. Hitchings, who had been appointed to the newly created office of State Entomologist in 1905, largely on account of the new insect problems caused by the brown-tail moth invasion.

In Connecticut the Stonington gypsy moth infestation was vigorously attacked by the State Entomologist, Dr. W. E. Britton, with State emergency funds placed at his disposal when the infestation was confirmed. Direct Federal aid was not requested during 1905 but Federal scouts were assigned to check on the limits of the infestation which appeared to be confined to an area of about one square mile.

Although the existence of the Providence, Rhode Island, infestation had been discovered in 1901, organized measures for its control were not undertaken by the State until the spring of 1906 when a State law was enacted, patterned upon the Massachusetts law in many respects and providing for an appropriation of $5,100. The amount was soon found to be inadequate but a cooperative arrangement between the State and the Federal Bureau of Entomology made possible the continuation of the work without interruption. As part of the arrangement, a force of 22 men which had been working for the State was transferred to the Federal roll beginning July 23 throughout the remainder of the calendar year. The work accomplished was reported in detail by Prof. A. E. Stene who was appointed superintendent to administer the State law enacted earlier in the year, in his report for 1905, made to the Rhode Island General Assembly atiits January session, 1907. All materials and equipment used were durnished by the State from the gypsy moth appropriation, only the wages of the workers were paid from Federal funds in the amount of approximately $4,000. The work performed was confined principally to creosoting egg clusters, clearing cleaning up and burning infested brushland in the city of Providence and the town of Cranston, and some scouting of localities in the northeastern part of the State, although earlier in the summer a considerable number of burlapped trees were tended.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1907

To quote Mr. Kirkland in his third annual report as superintendent, suppression of the gypsy and brown-tail moths in Massachusetts during 1907 "was vigorously prosecuted along the general lines found to be desirable and effective in previous years." The Act of 1905 provided $75,000 for the field work up to May 1 to which was added, on May 17, an appropriation of $220,000, and on the same date the $10,000 parasite appropriation was increased by $15,000.

Continued emphasis was placed on clearing infestations of both moths along roadsides to prevent scattering and spread of the caterpillars which might drop from the trees upon passing vehicles, and on reduction of the infestations in the thickly settled residential area, parks and public squares, which were a great source of annoyance and damage. For the first time funds were available to begin an effective campaign against the large woodland colonies and to more closely scout the outlying sections to determine the definite extent of the infested area. A noticeable improvement was evident in the cooperation between the municipal authorities and the State superintendent's office, and the greater efficiency of the men engaged on the work was reflected in the accomplishments reported.

During the year the maximum number of men employed on the work in the infested cities and towns was slightly over 1,800 and they were directed by a force of 40 men from the central State office. Nearly $340,000 was expended in municipal funds for wages of employees and for materials and equipment used, of which over $170,000 was reimbursed from the State appropriation. The total payroll was almost $275,000 and supplies cost over $60,000. The exact figures are published in the annual report of the superintendent for 1907.

The roadside work represented at least one half the efforts of the year and resulted in intensive work along 9,000 miles of streets and roads. Operations in the worst infested residential sections were this year extended to the more thinly populated farming districts so that before the caterpillar season began practically the whole infested territory had received some treatment with the exception of the woodlands. The usual methods of attack were pursued, egg clusters were creosoted, brush cleared and burned; worthless trees cut and woodland colonies near the roads were thinned during the fall, winter and spring; infestations were sprayed where possible, and many thousands of trees were banded with burlap or tanglefoot. Brown-tail moth webs were cut and burned whenever found in the course of the gypsy moth work, although special effort was not given to this except where the infestations were apt to be of particular nuisance in residential areas.

The amount of spraying increased steadily with the increase in the number of spraying rigs purchased and placed in operation by the cities and towns. During the summer there were 54 power sprayers and 38 hand outfits in use in the field and this did not include the very large number of machines owned and used by private citizens. No report of acreage covered or the amount of spray material used was made but improvements in the equipment were noted which resulted in greater and more economical coverage of the foliage.

By an amendment to the Act of 1905, the State superintendent was authorized to give special assistance in treatment of the moths in parks, woodlands, and other places of public resort, where there appeared to be danger of spread of the caterpillars by persons or other

means. This treatment was carried out in cooperation with the cities in areas publicly owned and by the State alone in the one case of a privately held woodland. Less than $10,000 was expended in this manner but the work seemed of great importance when the danger of spread from such sites is considered. (Plate XXVI)

During the fall intensive scouting was undertaken, in the territory west of the known infested district, for the first time in the thorough manner necessary to determine correctly the outer limits of the Massachusetts infestation. Owing to circumstances existing at the time in the labor market it was possible to employ a large number of experienced workmen and 70 of the best qualified men were chosen as scouts. These men were divided into crews of 5 to 8, which were placed under the direction of Messrs. Harry B. Ramsey and Saul Phillips, who were thoroughly capable men with the most efficient records on the work over several years. As a result of the scouting operations the gypsy moth was discovered in an additional 15 towns as far west as Fitchburg and beyond Worcester in the town of Leicester, which increased the known infested area in the State to 3,148 square miles. It was planned to continue the scouting throughout the winter in this direction since it was not anticipated that the outer limits had been reached.

Intensive scouting was under way, also, throughout the wooded section of the North Shore in Beverly, Manchester, Gloucester and vicinity, an area which was known to be generally infested, to determine the probable cost of clearing the infestations found. The estimate was to be the basis for a general campaign, with liberal financial cooperation by the infested towns and several of the large

property owners residing there, to protect the woodlands generally as well as the trees on many valuable private estates where the owners had spent large sums without complete success because of spread from the untreated infestations in the woodlands.

The results of the efforts this year were very noticeable. The residential areas were comparatively free of the pests for the first time since 1899, the woodlands in the centrally infested districts exhibited little if any damage and progress toward reduction of the infestations in more remote woodlands was becoming apparent. Some few sections evidently should have had greater attention owing to some increase in numbers of the insects, a result due principally to lack of sufficient funds when most needed. It was planned to overcome this situation the next season.

Continued help was furnished by the Metropolitan Park Commission, the Metropolitan Water and Sewerage Board and the Massachusetts Highway Commission, particularly. The Metropolitan Water Board devoted its greatest attention to the lands under its control about the Spot Pond Reservoir where a great deal of creosoting and banding was done and 23 acres of woodland was sprayed, at a total cost of nearly $6,500. Brown-tail moth webs and gypsy moth egg clusters were destroyed wherever found on other locations of the water board's property so that the expenditures for moth work for the year amounted to $10,700.

The Metropolitan Park Commission reported progress in the reduction of infestation throughout the reservations and parks in its charge. No serious defoliation occurred at any point and the number of egg clusters appeared to be much less than in the previous year.

Work along the State highways was performed, at the request of the State Highway Commission, under Mr. Kirkland's direction, by local organizations or by contract. A special fund was set up for this work by the Legislature of which $7,019 was expended. Roadside trees were treated and brush cut along these highways in 65 cities and towns.

In March 1907 the writer began special work for the State of Massachusetts, consisting principally of a study of mortality of brown-tail moth larvae in the winter webs, which included parasites, disease and winter killing, the collection of data on the cost of spraying with different types of equipment in the different towns, and investigations of tree banding materials for the purpose of securing a cheaper and more effective product, as well as the direction of the colonization and biological work on imported Calosoma beetles. On July 1, 1907 he was appointed as an expert in the Bureau of Entomology and served in Washington from September until the following spring when experimental work was resumed at the gypsy moth parasite laboratory. With the exception of a period during the winter of 1908-1909 which was spent at the Bureau and a brief period of service as a member of the original Federal Horticultural Board in 1912 his work on the Federal gypsy moth project has been continuous.

The importation, breeding and colonizing of parasites continued with increased efforts, due in part to the added appropriation by the State Legislature of $15,000 making a total of $25,000 which permitted purchase of much needed improvements in the laboratory equipment and the financing of the importation of a greater amount of material from abroad. Mr. Titus was obliged to leave the work to avoid a serious impairment to his health from the brown-tail moth poisoning and Dr.

Howard detailed Mr. W. F. Fiske to replace him. Mr. Fiske had shown great skill in his previous work in the Bureau on forest and parasitic insects which seemed to fit him particularly for the gypsy moth and brown-tail moth parasite work.

Dr. Howard returned again to Europe where he spent May and June to give additional instructions to the corps of collectors already engaged, to engage new collectors in the countries visited earlier, and to explore the possibilities of parasite importations from Russia. The trip resulted in receipt of much more material than ever before, necessitating the removal of laboratory quarters from North Saugus to Melrose Highlands, Massachusetts where more space was available, and the employment of additional laboratory assistants. From the brown-tail moth winter web material received, nearly 40,000 specimens of Pteromalus egregious and nidulans emerged and the majority were colonized in the field. These parasites and numbers of the predatory beetles Calosoma sycophanta and inquisitor were recovered this year, indicating they had become established, survived the winter and reproduced. Parasites of the genera Apanteles and Meteorus had been reared and bred in the laboratory as well as two species of egg parasites. [illegible]

In spite of the progress made in the parasite work dissatisfaction with the speed, or lack of speed, in obtaining immediate success was expressed by several influential citizens of the State, some of whom felt that everything possible was not being done to secure successful introduction of parasites. One group, which was highly critical of the methods employed by the State officials to suppress the gypsy moth, proposed to hire Mr. Elwood Cooper, California Com-

missioner of Horticulture, to attempt parasite introductions at their own expense if the State would not agree to do so. Mr. Cooper and his assistants were largely instrumental in the successful introduction of the predatory (Vedalia) Novius cardinalis, ladybird beetle, from Australia to California in 1889 which resulted in excellent control of the cottony cushion scale in California, and, although less successful in later parasite importation, he had acquired a wide reputation as an enthusiast in destroying noxious insects by means of parasitic control. Negotiations reached the stage where Mr. Cooper proposed for the sum of $25,000 to wipe out the gypsy moth and the brown-tail moth by parasites within two years, provided he had a free hand without interference by State or Federal officials, and that failure would cost nothing. The unscientific aspects of the proposal were pointed out but through the influence of those interested in the matter the discussion reached the Legislature where it was suggested, to end the controversy that Mr. Kirkland should be directed to secure additional counsel and advice from other workers. A $15,000 special appropriation was made available for this purpose. Mr. Kirkland was not restricted in his choice of counsel and invitations were extended to the following experts:

Prof. Edward M. Ehrhorn, Deputy Commissioner of Horticulture, California.

Prof. Herbert Osborn, Ohio State University, Prof. of Entomology.

Dr. John B. Smith, Entomologist, New Jersey Agricultural Experiment Station.

Prof. S. A. Forbes, State Entomologist, Illinois.

Prof. E. P. Felt, State Entomologist, New York.

Prof. H. A. Morgan, Director of the Tennessee Agricultural Experiment Station.

Prof. M. V. Slingerland, Cornell University, Ithaca, New York. These men were all experienced economic entomologists,noted investigators and nationally prominent.

In addition several foreign entomologists who attended the Triennial Meeting of the International Zoological Congress in Boston in the summer of 1907 were invited to inspect the gypsy moth work with special reference to the best methods of parasite introduction and control. The list included:

Prof. Charles P. Lounsbury, Government Entomologist, Cape Town, South Africa.

Prof. Walter W. Froggatt, Government Entomologist, New South Wales, and also investigator of insect problems for Victoria and Queensland, In Australia.

Dr. James Fletcher, Dominion Entomologist, Canada.

Prof. R. Blanchard, University of Paris, France, and member of the French Academy of Medicine.

Dr. G. Horvath, Director of ZoologicalSection, National Hungarian Museum, and formerly Director of the Entomological Station of Hungary. Both Doctor Horvath and Professor Blanchard were familiar with the two moths and their parasites.

Dr. Richard Heymons, Extraordinary Honary Professor andCustodian of the Zoological Museum of the Royal Institute of Berlin.

Prof. A. Severin, Conservator at the Royal Museum of Natural History of Belgium, and member of the Superior Council of Forests.

These men at various dates spent one to several days at the laboratory and in the field, carefully observing the methods used in importing, breeding and colonizing the parasitic material, the technical aspects of the work, and the accomplishments obtained. Their findings are published in full in the third annual report of the superintendent. They were practically unanimous in their praise for and satisfaction with the work, and suggested only a further extension of the efforts to secure new parasites particularly from Japan.

Federal and Other State Gypsy Moth and Brown-Tail Moth Work - 1907

The Federal scouting work begun during the fall of 1906 was continued in Maine, New Hampshire and Connecticut in a limited way throughout the winter and until June 1907. It soon became evident, owing to the discovery of so many infested towns, that an increased appropriation would be necessary to examine the outside territory and to determine the actual limits of the gypsy moth infestation. In May 1907 Congress appropriated $150,000 to carry on the work and this money was made available for immediate use. During the year infestations were found and treated in five towns in Maine east of the New Hampshire line in addition to those found during the fall previously, in New Hampshire 17 additional towns were found infested including Rochester on the north adjacent to the Maine border, Milford and Hollis to the west on the Massachusetts border, Concord and many towns between. Crews scouted the Stonington infestation and surrounding towns in Connecticut but no new colonies were discovered there; apparently this infestation was limited to its original location.

Roadside work was pressed during the late winter and early

spring in Massachusetts and 45 miles of protective belt thinning was completed and egg clusters treated up to the caterpillar season. These belts were then treated by placing tanglefoot bands on all the trees to prevent the caterpillars from ascending into the foliage. As soon as the caterpillars hatched arsenate of lead spray was applied for which purpose 4 spraying units of 500 to 600 gallons capacity had been purchased. After the spraying season the thinning work along the roads was continued and by the end of the year an additional 60 miles of the 100 foot protective belt had been placed in condition for further treatment. This work was carried on by agreement with the Massachusetts authorities, in the same manner as during the fall of 1906, on main travelled highways, and was supplementary to the roadside treatment done by the State organization in an effort to prevent spread of the pest by accidental carriage of the caterpillars which might fall on passing vehicles from the overhanging trees.

The New Hampshire Legislature in 1907 enacted a gypsy moth law similar in its principal features to the Massachusetts law and appropriated $12,500 a year for two years for a campaign againse the moths. Most of the State appropriation was spent the first year on a private contract for burlapping. All trees within 100 feet of infested trees in the towns bordering Massachusetts and along the coast were burlapped and Mr. G. E. Merrill was employed to inspect the work. The available funds were insufficient to complete the work. At the close of the year Col. Thomas H. Dearborn was appointed State Moth Agent. Federal work in this State was confined to scouting and treating the infestations found.

In Rhode Island six towns surrounding Providence were found infested with the gypsy moth after scouting in the winter and spring of 1907. The State appropriated $10,000 for the work of suppression and with assistance furnished by the Bureau of Entomology considerable progress was made in the effort to reduce the infestations. Thorough inspections were made by Bureau scouts throughout the area and during the winter nearly 80,000 egg clusters were found and destroyed. A large amount of work was done repairing trees and removing undesirable brush in the woodlands. As a result of these intensive efforts only 7,500 egg clusters were found the following winter and several colonies were believed to have been exterminated. The brown-tail moth was not found in the State.

Since the scouting in Connecticut failed to reveal the existence of any gypsy moth colonies outside of the Stonington infestation, Federal aid in that State was not requested. Sufficient funds were available for the State crews under direction of Dr. Britton to carry on the campaign of extermination and where 10,000 caterpillars had been destroyed in 1906 only 118 egg clusters were found and creosoted during the following winter. The brown-tail moth was not reported in Connecticut.

The Federal work in Maine was directed mainly against the new gypsy moth infestations found in the later winter and spring expecially in several large woodland colonies in Kittery and York which were treated intensively by clearing out brush growth, creosoting egg clusters, and preparing the area for the work against the caterpillars in the summer. The main efforts of the State were concentrated on fighting the brown-tail moth. State funds, supplemented by town

appropriations and privately subscribed money, were expended in a drive to collect brown-tail webs in the vicinity of York in the winter of 1906-1907. On January 18, 1907, the collection amounting to 120,000 webs was burned. In spite of this work, however, the brown-tail moth continued to spread with great rapidity and infestations were reported in many towns east of the previously known infested area. The State work in Maine was this year in charge of Capt. E. E. Philbrook.

In addition to parasite studies at the laboratory, which are referred to in some detail as part of the 1907 annual report of the Massachusetts Superintendent for Suppressing the Gypsy and Brown-Tail Moths, experiments were carried on by Mr. F. H. Mosher, Entomologist in charge of the Massachusetts Parasite Laboratory, to determine the feeding habits of young caterpillars particularly on white pine foliage. The results that Mr. Mosher secured confirmed observations made in the field that first stage gypsy moth larvae must first feed upon dedicuous foliage before they are able to attack pine.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1908

Climatic conditions during the winter and spring were ideal for insect development, winter killing was at a minimum due to the mild season and the spring was early, warm and dry. This brought about a rapid increase of damage by the gypsy moth caterpillars in those woodlands where it had not been possible to treat the infestations as thoroughly as desirable for proper control, and the resources of the officials were severely taxed to prevent damage in the residential and roadside sections.

Despite conditions, however, the fight against the moths was carried on along the same lines as in the preceding years and results achieved were most satisfactory. State appropriations of $300,000 were available for the work in the field and it was possible to increase the woodland program, partly because of improvement and greater efficiency displayed in the residential district work. Several cities and towns appropriated added sums for work in the woodlands which aided greatly in reducing the threat to sections where suppressions had been earlier attained. Over 2,400 men were engaged in the work at the height of the season, a larger force than ever before so employed. The spirit of cooperation exhibited by property owners was commendable, particularly in districts where the brown-tail moth was most prevalent. Some apathy was noticeable where damage was not appreciable but this attitude was not the rule.

Scouting work was continued on a larger scale than previously throughout the winter and approximately 100 well trained and experienced men were employed. As a result several towns to the west and south and on Cap Cod were scouted for the first time and added to the growing infested area. Small colonies were found and treated in Templeton, Oxford, Attleborough, Taunton, Dennis, Wellfleet and towns between. The main roads through Springfield to Huntington and along the Connecticut River were scouted, also, and small isolated infestations were found and treated in Warren, Palmer, Springfield and Greenfield. The number of municipalities now listed as infested by the gypsy moth totaled 192. Scouting for the brown-tail moth was resumed in the fall for the first time since 1906 and infestations were found as far west as Ware, in the Tier of towns from Royalston southeastern-

ly to Southbridge, and all towns to the east including those on Cape Cod, a total infested area of 5,147 square miles.

This year inspection was made and some treatment was given to infested street trees and adjacent woodlands along nearly 10,000 miles of roadsides, and in addition there was considerable inspection work where no infestations were found. Special work was found necessary and continued in several badly infested public parks by giving extra financial assistance to the municipalities in which the parks were located. A large amount of spraying was done after extensive preparation by thinning operations followed by creosoting and banding.

Considerable help in the moth campaign was again contributed by State boards and commissions, by State institutions and private corporations on lands under their control. The Metropolitan Park Commission reported more reliance was placed on spraying for control due to the fact that most of the infested areas in the parks and reservations had been placed in good condition in previous years for this type of treatment. Practically the same approach was possible on land of the Metropolitan Water and Sewerage Board and a reduction in cost of the work to $7,500 was possible. Work along State highways was again placed under the charge of the State moth superintendent and was done by local gypsy moth forces in most towns at a cost of slightly over $6,500.

In 1907 a special scouting program was undertaken in the North Shore district in Massachusetts to determine as accurately as possible the extent of the gypsy moth infestation in the woodlands which threatened to nullify in a large degree the effectiveness of the work done each year at great cost by the property holders on their large estates in that area, and to arrive at some estimate of the cost of

a campaign to alleviate the situation. This scouting was completed in the early spring of 1908 and a statement concerning the infestations found was submitted to Col. W. D. Sohier, Beverly, Massachusetts, who represented the residents of the North Shore district. It was then agreed that the State would contribute $20,000 from the gypsy moth appropriation, the town of Manchester and the city of Beverly $5,000 each and residents of the North Shore $20,000 by subscription, to a special fund for woodland treatment, without regard to town lines, under the direction of the State superintendent. Scattered infestations were treated and thinning operations undertaken covering an area of about 1,100 acres. This was in preparation for spraying, on which principal reliance was placed for suppressive measures and four power sprayers of the largest type were purchased for the job. At the height of the season 420 men were employed and nearly the whole area which had been prepared by thinning was treated with spray. Scouting was resumed at the completion of the spraying and a second infested area was found for which similar treatment was needed and plans were laid for the work to be undertaken the next year. (Plate XXV)

Mr. W. F. Fiske continued in charge of the parasite laboratory work, assisted by Mr. F. H. Mosher of the State staff. Mr. A. F. Burgess was detailed by the Federal Bureau of Entomology to work on the predaceous beetle experiments, and Mr. C. H. T. Townsend was similarly detailed in charge of work on Tachinid parasites. Twenty-five thousand dollars was appropriated by the State for the work and thus, in addition to the usual work of importing and liberating parasites, it was possible to make a more thorough investigation of the habits and biology of the insects under study.

As suggested by the several entomologists who visited the laboratory in 1907, arrangements were made to explore the possibilities of securing parasites in Japan. For this purpose Prof. Trevor Kincaid of the University of Washington, Seattle, Washington, spent the entire season in Japan as an agent of the Commonwealth. Professor Kincaid succeeded in securing the cooperation of the native entomologists, devised a package for shipment of material, and through his efforts near 50,000 cocoons of the Japanese Glyptapanteles were received at the laboratory. Several other species including Tachinids, Hymenopterous, pupal parasites, and a number of egg parasites, were received also from Japan.

During the summer a large amount of European material was received, the parasites bred out and colonized as rapidly as possible. Nearly 200,000 individuals were released including approximately 114,000 Pteromalus, 11,000 Trichogramma, 4,560 Telenomus, 13,000 Apanteles,, 45,000 Glyptapanteles, 1,000 Meteorus, 2,000 Pimpla, 6,000 Tachinids, and 1,000 Calosoma sycophanta. There had been imported through 1908, in all, 23 species of Hymenoptera, 16 from Europe, 6 from Japan, and one common to both regions, 29 distinct species of Diptera parasitic on both the gypsy moth and the brown-tail moth, and 5 species of Coleoptera which feed on both moths, a total of 57 beneficial species. At least seven species were recovered in the field indicating their establishment, notably, Apanteles, Pteromalus, and Calosoma sycophanta, but none in numbers sufficient to be of immediate importance in controlling moths. Dr. Howard, in his report to the State superintendent, stated the outlook was most favorable and expressed complete confidence in the ultimate success of the parasite work.

On December 1 this year Mr. Kirkland resigned and the report of the work was submitted by Mr. L. H. Worthley, who was appointed by the Governor as acting superintendent.

Federal and Other State Gypsy Moth and Brown-Tail Moth Work - 1908

The program of work by the Federal Bureau of Entomology in Massachusetts was extended considerably in 1908 but the same general plan of operations was followed as in previous years. The roadside clearing work was vigorously pushed throughout the year and nearly 170 miles of 100 foot protective strips were treated in addition to the 130 miles previously opened and cared for. The Federal appropriation for the fiscal year of 1909 was increased by Congress to $250,000 and the larger part of this sum was expended in Massachusetts since conditions in this State presented the major problem for preventing spread of the gypsy moth.

Increased appropriation was particularly valuable for extension of cooperative work with New Hampshire since State funds, provided by the Act of 1907, in the amount of $12,500 were entirely inadequate to cope with the situation in that State. Although a formal agreement was not drawn up it was arranged that the suppression of the gypsy moth should be under the general direction of the Federal office. Most of the field workers were paid from Federal funds and the State furnished supplies and equipment. Some State funds were expended directly for intensive work at several heavily infested colony sites where it was necessary to relieve an emergency and to prevent immediate damage and spread. This work was accomplished under the direction of the State agent, Col. T. H. Deearborn, who had been appointed at the end of 1907 when it was evident that the contract plan follow-

ed that year had not been particularly efficacious. About 100 men were employed during the caterpillar season and they tended burlaps on about 125,000 trees. Later in the summer it was planned to make an intensive inspection of the territory beyond the known infested district and since it was proposed that a large area should be scouted the State was divided into two sections. Mr. Irving L. Bailey was placed in charge of the western section and Mr. Henry L. McIntyre was selected to supervise the eastern section. Both men had considerable experience in moth work in the field, Mr. Bailey having served as an inspector for the Massachusetts State Board of Agriculture for several years and Mr. McIntyre having been employed on town work and later with the Federal organization. Several expert scouting crews were assigned to their direction on November 1 and all the previously unexplored territory in the State south of Lake Winnepesaukee was covered and a double tier of towns west of the Merrimac River as well as the main routes of travel into the White Mountain region. Infestations were found in most of the towns inspected and as a result the known infested area was increased to include a total of 63 towns, as far north as Ossipee and Meredith, and west to Henniker and Wilton.

In Maine a considerable area adjacent to the known infested territory was scouted during the same period and new infestations were discovered and treated in five more towns bringing the total number infested in the State to seventeen. By the end of the year conditions generally were better than in the previous year, so that it was evident the cooperative efforts of the Federal and State workers were very satisfactory.

During the year small infestations were found in four more towns in Rhode Island north of providence, next to the Massachusetts line, in the course of the scouting work by the Bureau scouts, making a total of 11 infested localities in the State under treatment. Intensive work was continued, all the trees, shrubbery, fences, and buildings in the infested area were carefully examined for egg clusters and the work was checked upon afterwards by two experts to find any egg clusters which might have been missed. A large amount of thinning of brush and treatment of tree cavities was accomplished to place the infested area in a more satisfactory condition for thorough care and inspection. As a result the number of egg clusters found and treated was reduced from 7,500 to only 1,700. Ten thousand dollars in State funds was available this year and this was augmented by Federal expenditures for wages in nearly the same amount.

The Connecticut gypsy moth infestation at Stonington was again scouted by a Federal employee to check on the possibility of spread, but the results were negative. The work at the infestation itself was done by the State, with an appropriation of $2,500 and considerable progress was reported toward reducing the number of caterpillars found. The State employees also scouted the area in the vicinity as well as the main highways leading into the State of Massachusetts and Rhode Island and through the eastern part of the State. Special inspections were made in railroad freight yards, orchards and on the tree growth about public garages. Conditions appeared to be very favorable for extermination of the pest from Connecticut.

The brown-tail moth continued to spread rapidly to the north and east and although winter webs were destroyed wherever found in the course of the gypsy moth work an active campaign against the infesta-

tion was conducted only by the localities in which conditions were particularly annoying. The full extent of the brown-tail moth infested area was not determined since no examination for this purpose only, had been made except in Massachusetts but it is probably that it covered nearly 7,000 square miles.

The series of experiments started in the laboratory by Mr. Mosher in 1907 were the basis of an extensive field test by Mr. Rogers, made in the spring of 1908, in a five acre stand of white pine located in Arlington, Massachusetts. This plot was surrounded by many fruit and shade trees, as well as brush and undergrowth, which was heavily infested by the gypsy moth. The pines were banded with tanglefoot early in the spring and no other treatment was applied to any of the growth. When the egg clusters hatched the deciduous trees were badly defoliated, but there was no injury to the pines. The small caterpillars evidently were unable to feed on the pine and spun down to the ground, died, or fed upon the deciduous foliage but were unable to ascend across the tanglefoot bands into the pine foliage. (Plate XXXIa)

This experiment resulted in the adoption of tanglefoot tree bands as a very simple method for preventing destruction of valuable coniferous woodland and made it possible to develop pine forests regardless of gypsy moth infestation in the surrounding area. This information was immediately applied in the field operations as was customary on this project.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1909

In March 1909, by an act of the Legislature, the gypsy and brown-tail moth suppression work in Massachusetts was placed under the office of the State forester, Prof. F. W. Rane. The work was reorganized at once and Mr. L. H. Worthley, who had been acting in charge since

Mr. Kirkland's resignation, was names Assistant Forester, in charge of moth work. The field force was reduced from 53 men to 19 by re-districting the infested area from six divisions, each headed by an agent with several assistants, to fifteen smaller divisions, each superintended by an agent without assistants, and with four inspectors available for assignment to special work from the main office. The supervisory force were furnished with motorcycles.

In the field the same general plan of campaign was followed except less direct supervision was exercised over the town organizations. The usual methods for suppression were prosecuted. Scouting for the gypsy moth was carried on but only those places most exposed to infestations were covered. For this purpose 15 men were employed to examine several towns along part of the western edge of the infested area and 6 men did similar work in towns east of Rhode Island. Under a new arrangement most of these men were paid from the funds of the towns scouted. Four isolated towns within the western limits of the infested area were added to the total infested as a result of the scouting but in others no infestation was found. Special attention was given again to the possibility of finding isolated infestations along the main travelled highways in the western part of the State, in the Berkshires and through the Connecticut River Valley. No infestation was found on this inspection, however, and in Springfield, Greenfield, Palmer and warren, where infestations were found in 1908, the scouting revealed that these infestations had been eradicated by the prompt measures taken at the time they were discovered. As a result of the season's scouting it was calculated the gypsy moth infested area comprised 3,950 square miles at the end of 1909.

As already noted the usual methods of creosoting gypsy moth egg clusters and thinning operationsto prepare woodlands and roadsides for efficient treatment were continued throughout the winter, spring and fall of the year. In respect to the thinning work the State Forester's office emphasized the reforestation phase of gypsy moth suppression work. For many years good management of the treatment work against the gypsy moth made necessary the application of certain thinning methods which not only aid in the destruction of the pest but incidentally result in increasing the value of the treated woodland. The primary purpose of thinning work, of course, was to accomplish gypsy moth control or extermination in the most efficient and economical way possible, and to reduce or eliminate the damage caused by this insect. In his report for 1909, the State Forester stressed the possibility and desirability of introducing modern forest management as the best if not the only means for attaining insect pest control in the future.

Spraying operations during the year were conducted on a larger scale then in any previous year. The number of men including town and city employees reached a maximum of 2,750 at the height of the season and there were 150 large power machines in operation and 200 hand outfits, most of which were owned and operated locally. About 300 tons of arsenate of lead were used and the acreage sprayed in the infested district was reported to total 7,776. During the season 698,597 burlap bands and 26,313 tanglefoot bands were placed on the trees and tended.

The work against the gypsy and brown-tail moths on trees within State highways was paid for as usual from a separate moth fund appro-

priated to the State Highway Commission and at the Commission's request remained under the supervision of the State Forester's office. Trees on sections of highways in 80 towns were treated and the work cost slightly over 5,000 dollars.

Most of the special North Shore work in the Beverly-Manchester section started in 1908 was accomplished during the first half of the year. About 2,138 acres of infested woodland were thinned, cleaned and sprayed, nearly double the area treated in 1908, and the cost amounted to slightly less than $59,000 as compared with the cost of $50,000 for the 1908 program. In the spraying season 8 spraying machines were used and were in constant operation for 25 days, consuming about 55 tons of arsenate of lead. In his report the State Forester states that as a result less than five acres of the treated woodland showed any defoliation during the caterpillar season following. The latter part of the year was devoted to checking over the territory to plan for the work of 1909 and to complete arrangements with Colonel Sohier in respect to the financial participation by the North Shore residents whom he represented and who cooperated with the State in this special undertaking.

Parasite importations and liberations in the field continued to increase and recoveries from earlier attempts to establish parasite colonies were encouraging. Thirty-three colonies of calosoma beetles were planted in June consisting of 32 colonies containing 6,100 beetle larvae reared at the laboratory and one colony of adults which were imported. Observations made in the vicinity of sites previously colonized revealed a most satisfactory increase and spread of the

beetle population. In his report to the State Forester, Mr. Fiske stated 90,000 individuals of the gypsy moth egg parasite Anastatus bifasciatus were liberated in five colonies, as well as 26,000 of another egg parasite, schedius kuvanae. A good number of the Japanese parasite, Glytapanteles fulvipes, were released, also. Blepharipa acutellata, which is a very important parasite of the gypsy moth in Europe, was received for the first time in living imported gypsy moth pupae and material was placed in hibernation for liberation the following year. It was reported also that Monodontomerus aereus, a pupal parasite of both the gypsy moth and the brown-tail moth, were recovered to an extent indicating the original liberations in 1906 had multiplied so that they were in 1908 distributed over an area of nearly 3,000 square miles.

Dr. Howard added to the parasite report information concerning importations of brown-tail moth webs and gypsy moth material from various parts of Europe, also information on his trip to Europe for the purpose of checking on the collecting work with the many European collaborators. Prof. Trevor Kincaid did not return to Japan but recommended that Prof. S. I. Kuwana of the Imperial Agricultural Experiment Station at Tokyo continue his cooperative endeavors in forwarding desirable parasitized material. In 1909 Professor Kincaid was sent to Russia but in spite of the cordial reception he was given by the Russian government and the entomologists with whom he came in contact, much of the potentially valuable specimens shipped were received in poor condition at the laboratory.

Studies were continued on the gypsy moth wilt disease by Dr. H. N. Jones under the direction of Dr. Theobald Smith of the Harvard Medical School. Definite results of the studies were not reached at

this time particularly in determination of the causal bacteria. Other experiments on the disease were undertaken without final determination by Mr. William Reiff of the Bussey Institute and Mr. James W. Mavor, a student, working under the direction of Dr. E. L. Mark of the Harvard Zoological Laboratory who investigated to determine whether Protozoa were involved. Dr. G. P. Clinton investigated a Japanese fungous disease of gypsy moth larvae.

The fungus attacking the brown-tail moth remained a source of considerable interest and field plantings of spores reared by Dr. A. T. Speare in the Harvard Laboratory were numerous and the results appeared to be encouraging.

Federal and Other State Gypsy Moth and Brown-Tail Moth Work 1909-1910

In summarizing the reports of the Federal Bureau, beginning with 1909, the data on accomplishment will cover a period conforming with the Government fiscal year which terminates annually on June 30. Data concerning State work will cover calendar year periods unless the reports from which they have been taken conform to the Government fiscal year.

In view of the increasingly large territory infested by the gypsy moth throughout Massachusetts, New Hampshire and Maine, it became apparent there was need for larger expenditures by the Federal Government for continuation and expansion of the efforts already put forth to check the spread of the gypsy moth in New England so that Congress voted in February 1909 to appropriate $300,000 for the work.

The larger share of the work was conducted as heretofore in Massachusetts, where the infestation was heaviest and offered the greatest danger of spread. Protective strip work on roadsides was

continued and during the year nearly 150 miles of strips were thinned out, 50 to 75 feet wide, and prepared for banding and spraying treatment. Although it had been arranged for some of the older thinned roadsides to be cared for by the towns nearly 300 miles of the roadside strips prepared in the preceding season were inspected and kept free of the pest, making an aggregate of 450 miles of roadside infestation cleared and placed in condition to prevent spread from this source. This work, while carried on in cooperation with the State of Massachusetts to avoid overlapping and duplication of effort, was entirely independent of the State work and was planned definitely for the purpose of preventing spread of the gypsy moth. It was without doubt a real factor in reducing the local intensity of the infestation, with particular benefit where the treated roadways passed through forested areas where the cost of treating large woodland areas would be excessive.

Control activities, directed toward prevention of spread of the gypsy moth, in New Hampshire was conducted as in 1907 and 1908 in clost cooperation between the State and Federal organizations. Owing to the small State appropriations it was necessary for the Bureau of Entomology to do the larger part of the work so that the State could reserve its funds to care for the urgent and extraordinary demands within the more heavily infested areas. Somewhat the same measures used in Massachusetts were applied, in a more limited amount however, to the infested woodlands along the main travelled roads leading into the summer resort sections. This appeared to be of greatest importance in lessening the danger of spread by carriage since the heaviest

travel over these roads occurred in the early summer at the time the small caterpillars were most numerous and most easily carried.

Scouting activities in New Hampshire were resumed in late October 1909 when 16 crews of 5 men each were assigned to extend the search started during the previous winter, into the northern and western parts of the State beyond the infested district. Up to the end of the fiscal year, with 5 crews added, the scouts examined 41 towns and found egg clusters in 21 towns not previously infested. Four towns previously infested and treated were found to be clear. As a result of the scouting by the end of the season the gypsy moth had been discovered in a total of 121 towns, including all the towns and cities in the counties of Rockingham, Strafford and Belknap, most of those in Hillsboro and Merrimac, and a few towns in Carroll County, an area of nearly 3,500 square miles.

The brown-tail moth was present in the entire lower half of the State extending nearly to the Connecticut River and north of Lake Winnepesaukee. A large part of the State moth appropriation was expended in an effort to reduce the infestation and some relief was secured, particularly where public interest was aroused sufficiently for the people to take measures themselves in their own behalf. Federal work was not directed primarily toward brown-tail moth control, but the webs found while applying gypsy moth treatment were always removed and destroyed.

The Rhode Island work progressed through the year with most satisfactory results. The persistent efforts of the combined State and Federal forces succeeded in accomplishing a marked decrease in

the gypsy moth infestation. Only 1,700 egg clusters were discovered and treated during the winter of 1909 throughout the infested area. During the summer about 150,000 trees were burlapped and tended. At the end of the year it was believed 4 of the 11 infested towns had been freed of the moth and the remaining territory was in excellent condition, promising a possibility of total extermination of the insect within a few years.

In Maine the general campaign against the gypsy moth was carried on as usual in close cooperation with the State officials, the program including the scouting of towns both in and outside the previously known infested district during the winter of 1909 and again in the fall and winter of 1909-1910, which revealed new infestations in 4 towns and the discovery of a large woodland colony of several thousand egg clusters in the town of York. The gypsy moth infested area in the State after the scouting was completed covered about 800 square miles. Cooperation of the residents of the infested area was most gratifying, particularly in their efforts to reduce the brown-tail moth infestations which were an annoying menace to the summer tourist business, and much private work was done in addition to the State and Federal work. It was reported at the end of the fiscal year that the general condition of the entire infested area, with very few exceptions, was greatly improved. The brown-tail moth was found in one-fourth of the State, as far north as the 45th parallel which was presumed at the time to be the northern limitoof its range.

Practically all of the necessary gypsy moth work at the Stonington infestation in Connecticut was done as in the past by State employees under the direction of Dr. Britton. The work at this infes-

tation was conducted from the first as a program for extermination and as a result of the vigorous methods pursued less than 100 caterpillars were killed in the summer of 1909 and only one egg cluster was found when the final inspection was made in the fall. Only a small amount of Federal assistance was called for to aid in this accomplishment and it consisted chiefly of scouting in the vicinity of the colony and checking on work done.

In the middle of December 1909 a resident of Wallingford, Connecticut, who formerly lived in Waltham, Massachusetts, discovered some egg clusters of the gypsy moth near his home not far from the center of the town and reported his find to the local borough warden. This report came to Dr. Britton's attention through a newspaper item and it was immediately investigated by one of his assistants who confirmed the fact that the egg clusters were those of the gypsy moth. A thorough examination was made in the section and it was ascertained that the infestation extended over half the borough. Dr. Britton without delay assigned Mr. Donald J. Caffrey and four men to search out, creosote and destroy all the clusters they could find. By the end of the scouting season in 1910 more than 8,000 clusters had been treated. Federal aid was requested and Mr. Rogers visited the colony the week following its discovery and sent Federal scouts to the scene to determine if the insect had infested other locations. They worked in the vicinity of Wallingford and New Haven, also in Berlin, Meriden and New Britian but no infestations were found. It appeared, judging by the number of clusters and the area covered that the Wallingford infestation started about four years previously and probably was brought in on a box or

cratesshipped to a shopkeeper by a dealer or a manufacturer from the infested area in Massachusetts.

No reports of the natural spread of the brown-tail moth into Connecticut from Massachusetts were made until early in April 1910 when specimens were discovered in the town of Thompson. About 12 winter nests were found on apple and pear trees which were thoroughly sprayed the following month. In June, one month later, brown-tail caterpillars were discovered in Putnam, Connecticut, but too late for treatment before they pupated. However, in 1909 while inspecting nursery stock the State Nursery Inspector found 52 winter webs of the brown-tail moth on some fruit seedlings received from France. Steps were taken to warn all nurserymen of the danger of the introduction of the pest on foreign importations. This resulted in advice that nursery stock from the infested district in Massachusetts had been planted on an estate in Port Chester, New York, only a few rods from the Connecticut line at Greenwich. New York inspectors investigated, found a few caterpillars and applied prompt, radical treatment which proved entirely efficacious.

These experiences in Connecticut with the brown-tail moth were not entirely unexpected, however, since in January 1909 Mr. G. G. Atwood, Chief of the Division of Horticulture of the New York Department of Agriculture, had warned nurserymen in New York and the nursery inspectors of nearby uninfested States of the possible danger that the pest had been introduced widely on nursery stock imported from France through the port of New York. The Chief of the Federal Bureau of Entomology spread the warning and made arrangements with customs officials to notify inspectors in all States of the arrival

of foreign nursery stock so that inspections could be made as soon as the material reached its destinations. Most of the States were thus able to make thorough inspections, although in some instances where State funds were not available local inspectors were deputized by the Federal Bureau and paid from Federal moth funds. As a result shipments of stock infested by the brown-tail moth were intercepted in 15 States scattered over the eastern half of the country from Georgia and Alabama west to Kansas and Nebraska. In New York alone over 7,000 brown-tail webs were found and destroyed. The inspection revealed also, the presence of one egg cluster of the gypsy moth on stock shipped into Ohio. So far as could be ascertained, the prompt action taken by the Federal and State authorities was successful in eliminating a serious threat of widespread dissemination of the pests.

A similar incident occurred in March 1909 when a foreman in charge of a scouting crew at Scarboro Beach, Maine, found gypsy moth egg clusters on some oak shimwood used in repairing railroad track. This wood had been shipped to several points along the Boston and Maine Railroad in southern Maine from a badly infested district in Medford, Massachusetts. The entire shipment was traced and it was believed all the infested material was found and treated. This occurrence emphasized the danger of spread of the gypsy moth by means of forest products that are shipped by rail after the egg clusters are laid, and led to the inauguration of an inspection system to prevent its recurrence in the course of railroad traffic. The railroads and express companies in the infested area cooperated fully so that beginning July 1, 1909, no forest products were accepted for shipment until a certificate or permit had been issued to show inspection had been made by the Federal Bureau of Entomology.

The permits were issued when forest products were offered for shipments between points within the infested area but inspection was not required. All products shipped outside the area, however, were carefully examined and if any form of the moth was found it was destroyed before a certificate was granted. During the year ending June 30, 1910, 3,475 applications for inspection were made, 2,751 permits granted, and 724 certificates were issued.

These arrangements, of course, were entirely informal and without the force of law or regulation excepting the rather weak provisions of the State laws which were designed mostly to control shipment of nursery stock.

The dangerous condition which existed of having no Federal law to control shipments of living plant pests emphasized the need for proper Federal authority to prevent the spread of such pests on interstate shipments and helped to create sentiment for such legislation, which was passed by Congress a few years later.

The parasite work was supervised at the laboratory in Melrose Highlands, Massachusetts by Mr. Fiske in close cooperation with the State of Massachusetts which furnished the laboratory quarters and provided for the expense of the collection and importation of parasitized material, and was continued under the original arrangements for its direction by Dr. Howard. The visit to Russia by Professor Kincaid in 1909 and the trips Dr. Howard took to Europe in 1909 and 1910 are mentioned in the summary of the work in Massachusetts for these years. One reason for Dr. Howard's trip in 1909 was to investigate the European methods of growing and shipping nursery stock with a view to preventing the recurrence of the introduction of in-

fested material in a manner similar to that referred to in a preceding paragraph. He took the opportunity while there, however, to check upon and refine the procedure for collecting and shipping parasitized material, from France in particular, which resulted in greatly increased receipts of important parasites at the laboratory during the year. As a result of the increased quantity and quality a greater number of tachinid parasites were reared in 1909 from the French material alone than from the total of all other importations of similar character.

Massachusetts Gypsy-Moth and Brown-Tail Moth Work - 1910

The seventh report of the State Forester states, "From the first the forestry work has been popular, while the moth work, on the other hand, has savored of unpopularity, for many reasons, but chiefly because of the law requiring property owners, through taxation, to defray a portion of its expense." It indicates that the efficiency of the moth work has been increased fully one third during the past season without increase in appropriations and that "a live-wire organization is our slogan."

The staff of the original Forestry Department and the moth superintendents were combined and a cooperative scientific staff is listed as well as a combined list of the local forest wardens and the local moth superintendents.

At the suggestion of Governor Draper an act was passed by the Legislature and approved March 2, 1910, providing that the appointment of local moth superintendents should be approved by the State Forester and an appropriation for "a sum not exceeding $150,000, the same to be in addition to the amount heretofore appropriated" for

the moth work, and an additional sum for experimenting with parasites and natural enemies for destroying said moths, "not exceeding $15,000", in addition to any unexpended balance of the former appropriation for this purpose, was approved March 18, 1910. Appreciation was also expressed for the kindly cooperation on the part of the United States Government through Dr. L. O. Howard, Bureau of Entomology and D. M. Rogers, Field Agent; also of Harvard University through Dean W. C. Sabine and the departments represented on the cooperative scientific staff.

Publicity was given on the gypsy moth by informative publications and the delivery of many public addresses and lectures. This was supplemented by running a five-car exhibit train for a tour over the Boston and Albany Railroad in cooperation with the State Board of Agriculture and the Massachusetts Agricultural College, where exhibits were shown and lectures given at many stations on different types of agricultural and forestry problems including the gypsy moth.

In addition to this, trains were run on electric lines so that the people, particularly in the western part of the State, had an opportunity to secure information on these problems.

The year's results on the gypsy moth work were encouraging in spite of many negative conditions and the fact that spraying was hampered by rainy weather in June. Scouting was carried on by more experienced men, particularly in the more populated areas, but in the smaller towns where there were no permanent scouts employed the quality of the work was not as good. Proposals were made to combine the work of small groups of towns under the direction of the State Forester, so that a more stable force could be employed, each town being assessed up to its legal liability.

Scouting work by the Federal forces disclosed new infestations in several towns bordering the known infested area. More efficient spraying machines were used during the season and improvements in equipment such as the Northley nozzle and the operation of long lines of one-inch hose resulted in better and more economical spraying. A portion of the sprayers owned by the State were sent on travelling missions to treat bad infestations which were present in many towns. Creosoting of gypsy moth egg clusters and the removal of brown-tail moth webs was done in some sections where conditions were such that spraying was impracticable.

A supply store was set up by the Forestry Department by means of which cities and towns which received reimbursement from the State could receive supplies as a part of the reimbursement. These supplies were purchased by the Department through public estimate which resulted in lower than current prices. Supplies aggregating $86,000 were stocked and supplies valued at $68,103.58 furnished to cities and towns at a saving of seventeen per cent. This method made it possible to secure high grade uniform supplies for use on the work and saved innumerable small purchases by towns at local prices. The supply building was also used for storage and repair of sprayers and other equipment. A list of supplies in stock was furnished the towns which were reimbursed with State money only. It was estimated that sales of salvaged wood would nearly pay for the cost of thinning operations.

In relation to national aid the State forester took the ground that Massachusetts was not receiving as much Federal aid as it was entitled to, based on a comparison of the expenditures made by the other

New England States with the funds appropriated by Massachusetts . It was argued that based also on the size and intensity of the infestation, a larger portion of the Federal appropriation should be spent in the latter State, and that Federal funds should be supplied to assist the State in woodland protection. He stated that "if this pest ever passes the Connecticut River in our State, the States west of us will surely become infested in time and the possibility of control will be almost beyond reason, while at the present time if the proper methods are used, chance of this westward spread is very small. While the Commonwealth is compelled to act under the present statute, it is powerless to employ trained men to do the work that should be done as each town is doing its own work with what might be called untrained men. On the other hand, if such Government funds were available, this district could be thoroughly handled in the proper manner. It is, therefore, self evident for one who understands the problem, that the Government appropriations are only one-third large enough and it should be the duty of the people of our State and adjoining States to make an appeal to Congress for money enough for effective protection."

The work on the North Shore which had been carried on jointly between the State of Massachusetts, some of the towns concerned and owners of large and valuable estates who are contributing to a fund for eliminating the gypsy moth in outlying woodland areas, was continued throughout the year under the chairmanship of Col. William D. Schier, whose report is quoted in part as follows:

"Roughly speaking, about 1,000 acres of woodland were cleared up and sprayed in 1908, about 2,100 acres in 1909 and something over

3,000 acres in 1910. The cost of the work is interesting, being approximately as follows: In 1908, $60,000; in 1909, $60,000; in 1910, nearly $57,000; the acreage covered in 1910 being about three times that cared for in 1908, and the total expenditure being somewhat smaller.

"The work has all been done under the direction of the State Forestry Department, of which Mr. F. W. Kane is the head, but it has been directly in charge of his gypsy moth superintendent, Mr. L. Howard Worthley, who has under him two extremely efficient assistants in charge of the work on the ground, Messrs. Saul Phillips and Walter F. Holmes. All of these gentlemen are entitled to the greatest possible credit for their efficient work, but for which there would have been but few trees left unstripped in the Beverly and Manchester woods. In fact, there seems no doubt that the conditions would now be unbearable had the colonies been allowed to spread during the last few years."

Federal cooperation in the North Shore work consisted in cleaning twenty-five miles of woodroads which were heavily travelled but roads from which automobiles were excluded were not treated. In addition to this, numerous species of parasites were colonized in areas which seemed to be the most suitable for their establishment and increase, and in some parts of the woodland areas, the wilt disease helped to decrease the caterpillar population.

The report also called attention to the initial work on the dispersion of the gypsy moth by the spread of small gypsy moth caterpillars by the wind, which was done under the supervision of Mr. A. F. Burgess by the Federal gypsy moth office in cooperation with the

State Forester's office. Bulletin No. 119 on "The Dispersion of the Gypsy Moth" was published later, February 11, 1913, by the United States Bureau of Entomology and contained much additional data on all phases of the natural spread problem and caused a radical change in the plans for field work in the prevention of spread of the gypsy moth.

Record is made of data secured concerning the danger of poisoning of birds, as a result of spraying with arsenate of lead. This information corroborated the data secured by Mr. E. H. Forbush, State Ornithologist of Massachusetts, and published in his annual report in the year 1909 by the Massachusetts Board of Agriculture.

A report by Dr. Howard on the parasite work outlined the plan for the field and laboratory investigations for the year and indicated that a larger quantity of parasitic material was received than during any previous year. Shipments of gypsy moth material and predaceous beetles and thousands of cocoons of the parasites themselves were sent from Europe and Japan, also other species of parasites from Europe which attacked the brown-tail moth. This report also includes data on the countries visited during 1910 by Dr. Howard and arrangements he made for shipment of material. In the autumn of 1910 Mr. Fiske visited Russia and France for the purpose of studying autumnal conditions of the parasites in their native homes in order to obtain needed information for future work.

The State Forester arranged with Dean W. C. Sabine and Dr. Roland Thaxter, Harvard University, to continue cooperative work on fungous disease. Dr. A. T. Speare was detailed for that work.

The report of Dr. Speare stated that a disease of the gypsy moth

somewhat similar to the Entomophthora which attacks the brown-tail moth, was successfully imported by Dr. G. F. Clinton of the Connecticut Agricultural Experiment Station who was sent to Japan for this purpose under the direction of Harvard University in May 1909. This disease was successfully carried through the winter by means of resting spores but it failed to develop during the summer owing to unfavorable conditions.

Studies of the wilt disease of the gypsy moth were arranged for under the direction of Dr. Theobald Smith of the Harvard Medical School; Dr. William Wheeler of the Bussey Institute of Harvard University; and Dr. E. L. Mark of the Harvard Zoological Laboratory. Dr. H. N. Jones submitted a report on this problem indicating that most of the information concerned was of a negative character and that further investigations would be necessary to solve the problem of utilizing it for insect control.

The work conducted under Dr. Wheeler by Mr. William Reiff had not been completed at the end of the year.

In March 1910 a bulletin was issued by the State Forester's office which was prepared by Mr. W. F. Fiske on the parasites of the gypsy moth and the brown-tail moth introduced into Massachusetts. This bulletin reviewed the work which had been conducted by the State of Massachusetts, in cooperation with the United States Bureau of Entomology, discussed the different species successfully imported, and showed by diagrams the progress of the work and the demonstrated fact that a sequence of the species of parasites attacking the gypsy moth and the brown-tail moth during the different stages of their development was necessary in order to bring about control of these in-

sects as no single species of parasite had demonstrated its ability in foreign countries to accomplish this result single-handed. It also indicated that progress had been made in establishing a sequence. This bulletin was preliminary to a Bureau of Entomology bulletin by Howard and Fiske on the technical phases of the gypsy moth parasite problem which was issued in 1912. 4/

4/ Bulletin 91, United States Bureau of Entomology.

Recommendations were made for legislation to authorize the State Forester to take supervision of gypsy moth and brown-tail moth suppression work in cities and towns desiring it or where economy or efficiency demanded it: and that a resolution be passed by the Legislature urging Congress to appropriate additional Federal funds for moth suppression.

Federal and Other State Gypsy Moth and Brown-Tail Moth Work 1910-1911

The field work during the fiscal year ending June 30, 1911, was carried on by the Federal Bureau of Entomology with practically the same methods used in preceding years, and was confined almost entirely to means for preventing the spread of the gypsy moth and the brown-tail moth work was the incidental rather than the primary objective. As a result of the intensive endeavors to keep the more heavily travelled roadsided clear, together with the work of the Massachusetts State forces, and no doubt aided by weather conditions, the increasing influence of introduced parasites, and the wilt disease, a noticeable decrease in the amount of defoliation was reported in the summer of 1910.

In Massachusetts a large part of the mileage of roadside work, which had been cared for by the Federal organization, was turned back to the towns in which they were located. The trees along these roads and the adjacent woodland strips now required only routine treatment since dead and defective trees, dead branches and underbrush had been removed and it was only necessary to continue treatment of egg clusters and caterpillars. This made possible the clearing of additional infested roadsides toward the outer edge of the infested territory in Massachusetts so that by the end of the season of 1911 the greater part of this type of work was either well underway or completed. Scouting of the towns beyond the known infested territory revealed the presence of the gypsy moth in 11 towns but no large colonies were found. The area scouted included the tier of towns west of the Connecticut River and in the southeastern part of the State. All infestations discovered in the course of scouting were thoroughly treated.

Favorable weather conditions throughout the winter offered the opportunity for extensive scouting in New Hampshire and as a result it was possible to examine completely, except in the woodlands, all the trees along the orads and open country in the outer ring of towns. The work in the more heavily infested section in southeastern New Hampshire was carried on along the main highways and egg clusters within 100 feet of the oradsides were creosoted. New Infestations were found in only 4 towns, several were found to be free, and generally the previously treated towns were found to be less infested upon re-examination.

Scouting in Maine resulted in finding 30 additional infested towns which nearly doubled the area which was previously known. With only tow or three exceptions only a single egg cluster was found in any of these infestations and they were properly treated as soon as they were discovered. At the beginning of the year, in 1911, Capt. E. E. Philbrook was succeeded in charge of the State work by Mr. A. O. Pike who had several years of practical experience on Federal moth work. The State appropriation did not become available, however, until late in the spring so that practically all the efforts for reduction of the Maine infestations were expended by the Federal force. In April an appropriation was made of $20,000 to be spent each year for two years beginning with 1911. It was felt that cooperation in the work in Maine would be improved and that progress could be expected in the endeavor to limit the spread and reduce the degree of infestation of the gypsy moth.

The gypsy moth work in Rhode Island was done throughout the fiscal year almost entirely with Federal funds and consisted largely of efforts to clean up a colony found by scouts at North Smithfield. About 500 egg clusters were creosoted and the woodland in the vicinity was cleaned and put in condition for future treatment by State workers. A slight increase in the general infestation of the State was apparent after the scouting season was closed, but, although cooperation with the State officials was excellent, the Governor vetoed the usual appropriation bill for moth work as well as other bills on the premise that tax revenue was insufficient to warrant such expenditures, therefore it was impossible for the State to give active support to any part of the moth work during the calendar year 1911.

Scouting was the major portion of the work done in Connecticut by the Federal Bureau of Entomology during the year and emphasis was placed on checking areas thought most liable to become infested by means of automobile travel. All the towns on the main route from New Haven north to the Massachusetts line were examined and no gypsy moth egg clusters were found. The State continued its work at the stonington infestation, and during the winter it was checked by a Federal scout who found only fragments of 3 clusters. The Wallingford infestation was checked by Federal scouts after the scouting season closed. At both colony sites the State employed every means at its disposal to eradicate the moths, by creosoting, banding, pruning, and, at Wallingford, spraying. Less than 30 egg clusters were found at the latter site the second year of work. It was not presumed that either colony had been cleared, however, and further intensive work was planned.

The brown-tail moth continued to spread, reaching serious proportions in Maine, New Hampshire and Rhode Island, and extending its range into western Massachusetts and northeastern Connecticut. It failed to spread further north in Maine, however, and hope was expressed that it had reached its northern limit in that State. Except, as noted before, where the winter webs were found and destroyed in the course of gypsy moth work by the Federal workers, most of the endeavors to alleviate the infestations were made by State and local forces and by private individuals.

During the gypsy moth spraying season 40 tons of arsenate of lead were used with 10 spraying machines in operation. This work was confined largely to roadside work in Massachusetts and New Hampshire as part of the plan carried on for this type of work in past seasons.

The quarantine inspection work continued under the same conditions inaugurated in the summer of 1909, with the added requirement that Christmas trees and decorations should be certified before shipment was permitted. This year the express companies were brought within the scope of inspection so that shipments by these carriers were certified as well as those by the railroads. A very small amount of infested material was offered for inspection. The need for Federal laws to safeguard shipments became even more apparent and concerted efforts were made to secure such legislation.

Field observations on the gypsy moth since its establishment in Massachusetts indicated that defoliation of practically all species of trees resulted particularly if the infestation was heavy. In some areas it appeared that there was preference being shown for certain species and this was emphasized as the result of the tests made in the area of pine growth by Mr. Rogers during the previous year. In order to secure more information he selected two badly infested woodland areas for observation, one at Chelmsford, Massachusetts, of 17 acres from which all species including oaks and birches were removed leaving a predominant stand of chestnut with some white pine, the other at Methuen, Massachusetts, where only pine, hemlock and maple were left standing. Both plots were untreated but bands were placed around the trees in the adjacent woodland to prevent caterpillar migration. At the end of the season the foliage of these plots was not damaged which led to the conclusion from this single test that pine, hemlock, chestnut and maple would escape injury if more favored species were removed. These ideas were put into field operation where thinning work was carried on but, in order that more complete information extending over a number of years under varying conditions

might be secured, detailed experiments were planned for the following season.

In July 1910 Mr. Fiske visited Russia, France and Italy collecting data and making observations on the gypsy moth and its natural enemies under late summer and autumn conditions, returning to the United States in Late October. The results of the year were reviewed and in January 1911 he returned to Europe and remained until July. Most of the work was done in southern Italy and Sicily and with the help of numerous assistants and collectors he was able to send large shipments of parasites during the summer.

The parasite work continued throughout the year in cooperation with the Massachusetts State Forester's office, with the employment of 37 men at the laboratory and in the field at the peak of the season in the summer. A large number of parasites and parasitized material was received from Russia and Spain through the collaboration of foreign workers as in previous years. One of the caterpillar parasites, Apanteles solitaruis, was liberated to the number of 23,000 adults. The pupal parasite, Chalcis flavipes, was liberated to the number of 10,000 adults. Several of the previously colonized parasites were recovered in encouraging numbers and it was possible to determine to some extent the range in which they had become acclimated in New England. Particular optimism seemed warranted in the large number of recoveries of the tachinid fly, Compsilura concinnata, which attacks both gypsy and brown-tail caterpillars as well as many native species, and the Calosoma beetle which was found abundantly in many sections. This year the Bureau of Entomology published Bulletin No. 101, "Calosoma Sycophanta", by A. F. Burgess, which is a detailed study of the life history of this predatory beetle, a description of

methods used for its importation to the United States and experiments conducted for laboratory breeding and colonization in the field. Importation of brown-tail moth webs was discontinued since it was believed that all the species of parasites which would thus be secured had become sufficiently well established.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1911

The State Forester's report for that year indicated that many cities and towns once badly infested were now in good condition and should be self-supporting without reimbursement from the State treasury. It indicated that the United States Government should take an aggressive stand on the gypsy moth work and that $1,000,000 a year at the present time would go much farther than a much larger sum later on. It expressed the hope that parasites, diseases and natural causes may be detrimental to this insect but that there are many chances of other sections of the country becoming infested before this result can be accomplished and that the only present practical means to prevent spread was through spraying and other well known mechanical methods.

During the year Mr. Charles W. Minott and Mr. Frank A. Bates, both of whom had been connected for many years with the State gypsy moth work in Massachusetts, resigned, the former to accept an appointment with the United States Bureau of Entomology.

The usual list of forest wardens and moth superintendents is published in this report.

Lectures on forestry and gypsy moth work were presented before meetings of many State and local organizations as well as before the third National Conservation Congress which met in Kansas City, Missouri, that year.

The progress that had been made in spraying, the introduction of parasites from foreign countries and the work with insect diseases were optimistically presented and stress was laid on the practice of modern forestery methods.

Roadside spraying had always been considered important and the high power sprayer which was developed by the State Forester's office had proven extremely valuable. Supplies furnished to towns and cities during the year amounted to over $95,000 and these were furnished in lieu of cash reimbursements.

On December 1, 1911 the cooperative work on parasite introduction together with experimental work relative to the control and prevention of spread of the gypsy moth was transferred from the office of the State Forester to the sole charge of the Bureau of Entomology of the United States Department of Agriculture.

A report on parasite introduction prepared by Dr. Howard indicated that several species already introduced had become established and that the Calosoma beetle had been found abundantly in many localities during the year. Two species of egg parasites had also reproduced in the field satisfactorily.

In lieu of depending entirely on the efforts of foreign agents for work in European countries Mr. W. F. Fiske spent the spring and summer abroad in Italy making observations on natural enemies of the gypsy moth and supervising the collection and shipment of material. His efforts werevery successful and the volume of material received at and colonized from the laboratory at Melrose Highlands was greater than in any previous year. During his absence Mr. A. F. Burgess took charge of the laboratory. Mr. Fiske returned to America in July

1911, and later in the year went back to Europe for preparatory work for the next season.

Investigations on the wilt disease, which for a number of years had been present and destructive to gypsy moth caterpillars more particularly in the areas which were heavily infested, were carried on by Mr. William Reiff, an assistant of Dr. W. M. Wheeler of the Bussey Institute of Harvard University, in cooperation with the State Forester. Mr. Reiff had charge of the greenhouse where material was prepared and disseminated early in the season. Later in the year he returned to Germany to study the disease and planned to colonize it on a more extensive scale next season than heretofore. A bulletin on this disease entitled "The Wilt Disease or Flacherie of the Gypsy Moth" was published by him under the direction of the State Forester in March 1911. (Contributions of the Entomological Laboratory, Bussey Institute, Harvard University, No. 36) which gives the details of handling and disseminating this organism artifically. The bulletin indicates that the dissemination of the disease is caused by the spread of the organism by the wind. Some years later experiments determined conclusively that the disease was not spread in that way. The use of this material particularly in woodlands as a cheap substitute for other methods of treatment was very popular with the public but it was determined later that the normal effectiveness of the disease developed where no attempts at colonization were made to increase its usefulness.

Investigations were continued on fungous diseases of the brown-tail moth and gypsy moth but practical means of utilizing these diseases were not determined up to the close of the year.

Control work on the North Shore was continued along the same lines as in previous years and with excellent results. Work along similar lines on a much larger scale in woodlands on the South Shore, particularly in the towns near Cohasset, was undertaken. Spraying and treatment work both for the gypsy moth and the brown-tail moth along State highways was also continued and the area treated was much greater than during the previous year.

The impression gained growth in certain sections of the State where infantile paralysis occurred in epidemic proportions that there was a distinct relation between this disease the the use of insecticides for spraying. This theory was determined as untenable and the anxiety concerning the dangers was relieved.

A summary is included of the gypsy moth conditions in each of the infested towns which is very useful for reference in comparison with other years.

An act was passed by the Legislature in 1911 providing that under certain conditions taxes assessed by local authorities for gypsy moth and brown-tail moth suppression on their property could be abated.

A bill giving the State forester authority to take charge of moth work in towns where no local organization exists or where the work is not effectively done was introduced in the Legislature but the act which was approved on May 26, 1911, restricted this authority to cases where the proper town officials should make request to have the work done. Only one town took advantage of this provision, however.

In view of certain recommendations made by the Governor in his annual message to the Legislature, in which he advocated a reorganization of the State Forester's office and placing the gypsy moth work under the control of a manager for the purpose of securing greater

efficiency in its conduct, a special hearing was held on June 9 and 13, 1911.

Prior to the recommendations the administration of the office had been investigated as well as other State institutions by efficiency experts and it is presumed that the recommendations by the Governor were based in part at least on the report of these experts.

At the hearing much testimony was given in favor of the work as conducted and opposition was voiced to the changes suggested. Statements were made, however, that unintelligent methods were used in controlling the gypsy moth and that the law was not being enforced effectively, which was causing public criticism and was likely to result in discontinuance of the work. The ground was taken that no reimbursement should be given to towns except on condition that the State funds to which they were entitled and the funds which they were required to appropriate be administered directly by the State authorities, unless the towns wished to do the work under their own management and at their own expense. Also that the tax levy for this work required in the State law should be mandatory and not permissive and that a larger appropriation should be made for parasites, $25,000 per year was suggested in lieu of the $15,000 which was usually made. Objection was also made to the State furnishing from its storehouse materials needed in the gypsy moth work, particularly insecticides at cost, unless the same privilege was extended to other individuals. Brown-tail moth work by the State should be discontinued and no funds should be appropriated except for parasite work unless the Forestry Department was completely reorganized.

The State Forester in his recommendations for funds for the calendar year 1912 recommended that appropriations be reduced as follows: by transfer of the parasite work to the United States Bureau of Entomology which in effect had already been accomplished; and by placing gradually more of the financial burden on the cities and towns. This was predicated on the idea that the State Forester would be given greater administrative powers than existed under the present arrangements.

In order that State expenditures might be curtailed and State aid for the cities and towns be gradually eliminated it was recommended that the State funds for 1912 be reduced from $315,000 to $250,000; for 1913 to $200,000; for 1914 to $150,000; and for 1915 to $100,000.

A State appropriation was made by the Legislature for the calendar year 1911 of $315,000 and was approved by the Governor.

The State Forester's report closed with the comment: "The encouraging features of the outlook in this moth work are as follows:

(a) Better supervision and methods.

(b) Improved equipment.

(c) A more definite State policy.

(d) Better cooperation with the United States Government

(e) Local town and city politics largely eliminated, and local moth superintendents held responsible for results.

(f) Modern forestry methods, proving great factors in successful economic moth suppression.

(g) Parasites and diseases proving more and more efficient."

Federal and Other State Gypsy Moth and Brown-Tail Moth Work
1911-1912

The experiment started in the early spring of 1911, mentioned in the report of fiscal year 1911, to determine the possibility that certain species of trees were immune or resistant to gypsy moth caterpillar attack, gave promise of conclusive results. Preliminary study of the season's work indicated the resistance or immunity of clear stands of pines, hemlock, chestnut and the maples, after removal of oaks, birches and willows, which seemed to justify extension of the experiment on a scale sufficiently detailed to accumulate data for comprehensive study of the problem leading to a policy for forestry management control of the gypsy moth. Plots were selected in about 250 localities in Maine, New Hampshire and Massachusetts, representing as near as possible all the differing woodland types and conditions of infestations, at which observations were carefully made from time to time. Data were taken for determination of the increase or decrease of infestation, parasitization, feeding habits, and other factors, under many varying conditions. It was planned to continue the experiment over a period of several years in anticipation that the data secured would make possible improved methods of thinning for gypsy moth operations, particularly in the more valuable growth and to determine whether natural factors could be utilized. These points were laid out in circles 100 feet in diameter in which detailed observations were made, together with contiguous areas where special data was secured, aggregating several acres in extent. The defoliation and food plant data secured was correlated with feeding experiments conducted under controlled conditions at the laboratory with 50 different native trees and shrubs using different stages of gypsy moth larvae.

In general, the field work for preventing the spread of the moths was conducted in practically the same manner as heretofore with continued emphasis upon clearing and cleaning up the roadsides of the main travelled highways, but most of this work was done at the outer edges of the gypsy moth infested territory since the policy of leaving the work on roads in the inner territory to the towns had been started in 1911. This policy was followed in Massachusetts and New Hampshire, and it was, therefore, possible to extend the roadside work to many of the lesser travelled roads on the outer infested area in these States. In August of 1911, egg clusters of the gypsy moth were found by employees of a forestry contractor at Lenox and Stockbridge, Massachusetts. Immediate steps were taken to delineate, by scouting, the extent of the infestation and in November another colony was found in the town of Great Barrington adjacent to Stockbridge. Scouting was continued throughout the winter by Federal men in all the surrounding towns in Berkshire County west to the New York State line. Considerable apprehension was felt over the discovery of these colonies, particularly since the infestation was so near New York State. The major part of the work of cleaning up the Berkshire colonies was undertaken by the Massachusetts State Forester's force and by the local officials in the infested towns, although all egg clusters discovered by the Federal scouts were creosoted when found. A thorough and systematic attempt to eradicate these colonies was made.

The New Hampshire work was interrupted early in the winter by deep snowfall and extreme cold, but work was resumed in April. Federal efforts were directed toward work in towns along the outer edge

of the infested territory with gratifying results. Most of the roads were scouted as well as large woodland areas, all egg clusters found were creosoted, and in a few towns previously infested it was found after a second thorough inspection that the gypsy moth had been eliminated.

The severe winter interfered as seriously in Maine as in New Hampshire. The seriousness of the situation there may be inferred by the fact than another notable increase in the infested area was reported. None of the new colonies were large and no great amount of defoliation was found yet the volume of work necessary to make any progress toward preventing further spread or increase in the amount of infestation overshadowed the possibility for doing the work unless more State work with greater appropriations should become available without delay.

No gypsy or brown-tail moth work was done in Rhode Island throughout the summer of 1911. The Governor of the State had refused to sign the moth appropriation bill for the year so that the State officials charged with the work were without funds for its prosecution. Since it was not the policy of the Federal Government to undertake sole responsibility for work within a State which was primarily the State's responsibility, Federal work was not performed in Rhode Island until the winter of 1912 when the State finally appropriated funds and was able to properly participate in a cooperative effort to ameliorate the situation. In January 1912, therefore, 100 Federal men were transferred from Maine and New Hampshire, and worked until April, scouting over two-thirds of the State. About 38,000 egg clusters were found and creosoted during this period.

Five new towns were found infested. The work was conducted on a severely intensive basis and with continued persistence it was believed the lost ground would soon be regained.

The situation in Connecticut, on the other hand, was most encouraging. Splendid cooperation was enjoyed with the State officials in every respect, who, with great energy, under the direction of Dr. Britton, had done most of the necessary extermination work at both the Stonington and Wallingford infestations. These sites were again checked by Federal scouts, no tract of the gypsy moth was found at Stonington and only five egg clusters were found in Wallingford during the period of examination in December 1911 and January 1912.

After a perusal of the scouting records for the year it became increasingly obvious that, with the exception of the isolated infestations in western Massachusetts, the spread of the gypsy moth could have occurred only by means of the wind. The locations of new colony sites and the size of the colonies allowed no other reasonable deduction. The infestations at Stockbridge and Lenox in Massachusetts, however, were obviously the result of the introduction of egg clusters upon nursery stock from a nursery in the heavily infested section near Boston, and they had built up in size for at least one or two years before their discovery.

The brown-tail moth appeared to have become less offensive throughout its range, fewer complaints were heard than heretofore except in Maine and New Hampshire where summer visitors were somewhat affected, although it remained a matter of serious proportions nevertheless. An extensive colony was discovered in North Adams by Federal scouts in the fall of 1911, who were checking upon the poss-

ibility of gypsy moth spread at the time of the findings at Lenox and Stockbridge. Over 13,000 winter webs were cut and destroyed in North Adams and the neighboring towns of Clarksburg and Williamstown, which seemed to have satisfactorily cleared up the danger of further spread. The brown-tail moth continued to spread in both Connecticut and Rhode Island, but the situation was handled by the State and local forces.

Inspection of forest products continued to occupy a large part of the time and funds of the Federal force. A total of 375 applications for inspections were received and resulted in removal and destruction of 72 egg clusters and 47 larvae from products inspected before shipment. Nursery inspection in Massachusetts is under the State Board of Agriculture but, when needed, Federal assistance was given so that a more nearly perfect quarantine might be maintained. Thus, during 1911 and 1912, Federal employees were detailed to assist the Massachusetts Nursery Inspector by scouting, creosoting, and cleaning up worthless brush in the vicinity of the more important nurseries in the State. An additional endeavor, proposed at the end of the fiscal year 1911, was made to prevent the artificial spread of the brown-tail moth. In July during the flight season of the adults, employees of the Bureau of Entomology were assigned to examine railroad trains each night at stations located near the border of the infested area. During the season 887 adult brown-tail moths were thus captured in and on the trains indicating that some long distance spread of this insect was avoided.

On December 1, 1911, a most important step in the organization of the gypsy and brown-tail moths work was culminated by the bodily

transfer of the parasite work from the cooperative status with the Massachusetts State Forester to the sole administration of the Bureau. Cooperation on this project had been satisfactory throughout the six years of its operation but the growing importance of the work due to other States being involved and the urgent desire of the State to be relieved of the annual expenditure of funds for this purpose seemed to warrant the change to a purely Federal project. Many of the force who had been employed by the State were transferred to the Federal roll. Mr. Fiske remained in charge of the parasite work and Mr. Burgess took charge of the laboratory during his absence.

In keeping with the policy initiated in the previous fiscal year the number of parasite importations was reduced and greater emphasis was placed on studies of the life history and adaptability of the parasites already introduced in this country. Field observations and collections indicated some of the species were becoming well established and dispersed widely throughout the infested territory, particularly the parasites of the brown-tail moth. Mr. Fiske again travelled to Europe late in November 1911 and spent most of the first half of 1912 in southern Europe with headquarters in Italy. He was accompanied on this trip by Mr. L. H. Worthley who had been given leave of absence by the Massachusetts State Forester from his duties as superintendent of the State moth work.

In the early part of the fiscal year,on July 29, 1911, the United States Bureau of Entomology Bulletin No. 91, "The Importation into the United States of the Parasites of the Gipsy Moth and the Brown-tail Moth", by Howard and Fiske was published. This publication was a highly important contribution to the literature on the subject and a valuable reference work of great interest to the work-

ers and the general public. It is a completely detailed report of the progress achieved, the methods used, and history of the several parasites discovered and introduced into this country.

The same year the bulletin on technical results from the parasite laboratory was completed. This bulletin is the United States Bureau of Entomology Technical Series No. 19; Part I, "The Parasites Reared or Supposed to Have Been Reared from the Eggs of the Gipsy Moth", by L. O. Howard, issued January 28, 1910; Part II, "Descriptions of Certain Chalcidoid Parasites," by J. C. Crawford, Issued April 30, 1910; Part III, "Investigations into the Habits of Certain Sarcophagidae," by T. L. Patterson, issued March 22, 1911; Part IV, "The Chalcidoid Genus Perilampus", by Harry S. Smith, issued April 22, 1912; and Part V, "Experimental Parasitism", by F. H. Timberlake, issued May 29, 1912. These papers are purely technical and not intended for popular distribution but serve as reports of the scientific research undertaken and as guides for future research studies.

Massachusetts Gypsy Moth and Brown-Tail Moth Work - 1912

The State Forester's report for the current year indicated a reduction in the State appropriation of $65,000 from that of the previous year. This included a saving of $15,000 on account of the transfer of the parasite laboratory to the United States Bureau of Entomology and $50,000 presumarly by curtailment in reimbursement of funds to infested towns in accordance with the State law. This was in line with the policy indicated in the previous report recommending a reduction of appropriations during this and/following the three years so as to bring future State expenditures to $100,000 an-

nually, by adopting a policy of self-support and greater financial expenditures by the cities and towns in the infested area.

At the beginning of the year Mr. L. H. Worthley accepted a position on the Government work and, after spending eight months in Europe as an assistant to Mr. Fiske in connection with parasite introductions from Europe, continued on Federal field work. His position on the State work was filled by the promotion of Mr. George A. Smith from a district superintendent to general superintendent of moth work. Mr. William Reiff who had carried on experimental work on a large scale with the wilt disease of the gypsy moth resigned August 1.

During the summer the State Forester was sent as a delegate to attend the Second International Entomological Congress at Oxford, England, and to make a study of the conditions in the Black Forest of Germany, and from the contacts and observations which he made became fully convinced that the solution of the gypsy moth and brown-tail moth problem depended on forest management.

In order to determine the species of trees which were most resistant to gypsy moth attack data on areas defoliated by the gypsy moth were collected by a trained forester between July 10 and July 24, in 39 areas in 16 towns and the city of Boston.

The report contains the suggestions that the tree wardens in the cities and towns in the State, who are elected by the people, should be appointed by the selectmen the same as the gypsy moth superintendents and forest wardens in order to eliminate politics and that these three town offices be combined in one, presumably under the direction of the State Forester's office.

It indicated that the gypsy moth problem in cities and residential sections had been solved by making them self-supporting, with the idea of using some of the money saved for reimbursement to small towns in the rural sections for necessary work.

With the transfer of the State parasite work to the Federal Government an arrangement was prepared for the Government field control work to be done in the towns along the outside border of infestation, the State and towns to be made responsible for gypsy moth control and improving conditions in the area east of this line. The report suggested that in the very lightly infested towns inside the border which is the responsibility of the State and towns to care for, that experienced foremen be imported to do this work, at least until local men have become sufficiently trained, and indicated "that in dealing with this moth problem it will be good business to keep up the work of the present with the iead of gradually placing the burden upon the towns and cities."

"In my last year's report a definite recommendation was outlined whereby the State appropriation should be lessened $65,000 last year and $50,000 each year thereafter for three years. I am still of the opinion that we should carry out that policy. Such a gradual curtailment on the part of the State would not interfere with the efficiency of the work.

"In dealing with the moth problem I am frank to say that every endeavor is being made to impress our employees with the idea, already alluded to in another place in this report, that better forestry is the solution. This means that we are to change our point of view from a policy that is unpopular and expensive, though necessary, to a constructive one, namely, the conservation of our forests. What a showing

could be made were we able to utilize the present expenditure in moth work for pure forestry! It is firmly believed that with a consistent policy we may attain that much coveted goal."

Work along the State highways on the gypsy moth and brown-tail moth was done under the supervision of the Forestry Department but paid for by the State Highway Commission in the amount of $8,064.22. In addition the State Forester expended $1,860.87 from gypsy moth funds on highways in 32 towns.

A report of the progress made in parasite introduction and colonization was made by Dr. Howard indicating that in general most species of the parasites were increasing, that the wilt disease was present to a greater or less degree throughout the entire infested area, and that parasites were bringing about a greater measure of control on the brown-tail moth than ever before, and that in considerable territory north of Boston it is safe to say that fifty per cent of the eggs, caterpillars or pupae were destroyed by imported parasites during the year.

Work on the distribution of the wilt disease by Mr. Reiff continued until his resignation in the summer of 1912 and a greater number of plantings of material was made than in any previous year, but thorough investigations showed that knowledge concerning this disease was still fragmentary and it did not appear advisable to continue colonization until more accurate information was available.

The following copy of a letter concerning the status of the disease by Dr. W. M. Wheeler is self-explanatory:

Bussey Institution
Forest Hills, Mass.
Nov. 20, 1912

Mr. F. W. Rane
6 Beacon Street
Boston, Mass.

Mr dear Mr. Rane: In obedience to your request I beg leave to submit to you my opinion in regard to continuing the practice of attempting to spread the wilt disease, or "flacherie", of the gypsy moth caterpillars by artificial means in the forest lands of eastern Massachusetts. It is obvious that any attempt thus to utilize the wilt disease in practice must be based on a precise knowledge of the methods whereby the disease may be contracted by healthy caterpillars. Although we have good evidence for believing that the disease may be contracted by healthy caterpillars that have fed on the excretions of diseased caterpillars, or the deliquesced portions of caterpillars that had died of the disease, we have at present no data to prove that the disease can be transmitted from diseased to healthy caterpillars by mere bodily contact or by germs borne through the air. Many experiments have been performed for the purpose of proving the method of transmission last mentioned, but these, in my opinion, have given merely negative or highly equivocal results, owing to the fact that the disease, in a mild or latent form, is chronically, and perhaps hereditarily, present in practically all the localities in which the caterpillars occur in eastern New England. The acute and economically important phase of the disease may, therefore, arise through unusual meteorological conditions, or through peculiarities of the plants on which the caterpillars happen to be feeding. Hence, there is no advantage in continuing such experiments till the precise methods of infection and of its specific organism have been determined by carefully controlled laboratory experiment andpprotistological investigation. Such investigations are being pursued, with improved facilities, by the federal Entomological Bureau in cooperation with the Bussey Institution of Harvard University, and may be

expected to yield, in the not too distant future, some adequate theoretical basis for a sound practical utilization of the disease in the field.

Very sincerely yours,

W. M. Wheeler

Professor of Economic Entomology"

Work on fungous disease of the brown-tail moth and gypsy moth was continued during the year and some 200 cases of brown-tail fungus material were shipped to State and town superintendents and 100 cases of the same material to private individuals during the first week in June. The results in most of the plantings were satisfactory. Similar experiments with the gypsy moth fungus gave negative results.

Gypsy moth work on the North Shore was continued under the same arrangements as were in force during the last few years which included financial cooperation and management by the State Forester's office supplemented by contributions from the city of Beverly and the town of Manchester and a long list of property owners in the North Shore territory. Excellent results were secured and the treatment of the woodlands in the region surrounding some of the most valuable as well as beautiful seashore property in that region provided ample protection. The expenditures from July 16, 1911 to July 30, 1912, including purchase of tools and supplies, aggregated over $55,000.

Publicity was given the State work by means of lectures before many State and local organizations and at field meetings in many widely scattered localities.

Appendix C

LAW RELATING TO GYPSY AND BROWN-TAIL MOTHS

(Chap. 381.)

An Act to Provide for Suppressing the Gypsy and Brown-Tail Moths.

Be it enacted, etc., as follows:

Section 1. Forethe purposes of this act the pupae, nests, eggs and caterpillars of the gypsy and brown-tail moths and said moths a re hereby declared public nuisances, and their suppression is authorized and required; but no owner or occupant of an estate infested by such nuisance shall by reason thereof be liable to an action, civil or criminal, except to the extent and in the manner and form herein set forth.

Sect. 2. The governor, by and with the consent of the council, shall appoint a superintendent for suppressing the gypsy and brown tail moths and shall determine his salary. The governor may, with the consent of the council, remove said superintendent at any time for such cause as he shall deem sufficient. In case of the death, removal or resignation of the superintendent the governor shall forthwith appoint a successor. On or before the third Wednesday in January in each year the superintendent shall make a report of his proceedings to the general court, which shall be a public document and shall b e printed. Said report shall separate so far as is practicable the expenditures on work against the gypsy moth from those on work against the brown-tail moth in each city and town.

Sect. 3. The said superintendent shall act for the Commonwealth in suppressing said moths as public nuisances, in accordance with the provisions of this act. For this purpose he shall establish an office and keep a record of his doings and of his receipts and expenditures,

and may make rules and regulations. He may employ such clerks, assistants and agents, including expert advisers and inspectors, as he may deem necessary and as shall be approved by the governor. He may make contracts on behalf of the Commonwealth; may act in co-operation with any person, persons, corporation or corporations, including other states, the United States or foreign governments; may conduct investigations and accumulate and distribute information concerning said moths; may devise, use and require all other lawful means of suppressing or preventing said moths; may lease real estate when he deems it necessary, and, with the approval of the board in charge, may use any real or personal property of the Commonwealth; may at all times enter upon the land of the Commonwealth or a municipality, corporation, or other owner or owners, and may use all reasonable means in carrying out the purposes of this act; and, in the undertaking aforesaid, may, in accordance with the provisions of this act, expend the funds appropriated or donated therefore; but no expenditure shall be made or liability incurred in excess of such appropriations and donations.

Sect. 4. Cities and towns by such public officer or board as they shall designate or appoint, shall, under the advice and general direction of said superintendent, destroy the eggs, pupae and nests of the gypsy and brown tail moths within their limits, except in parks and other property under the control of the Commonwealth, and except in private property, save as otherwise provided herein. When any city or town shall have expended within its limits city or town funds to an amount in excess of five thousand dollars in any one calendar year, in suppressing gypsy or brown tail moths, the Commonwealth shall reimburse such city or town to the extent of fifty per cent of such excess above said five thousand dollars.

Cities or towns, where one twenty-fifth of one percent of the assessed valuation of real and personal property is less than five thousand dollars, and where the assessed valuation of real and personal preperty is greater than six million dollars, shall be reimbursed by the Commonwealth to the extent of eighty per cent of the amount expended by such cities or towns of city or town funds in suppressing the gypsy and brown tail moths in any one calendar year, in excess of said one twenty-fifth of one per cent.

In the case of towns where the assessed valuation of real and personal property is less than six million dollars, after they have expended in any one calendar year town funds to an amount equal to one twenty-fifth of one per cent of their assessed valuation of real and personal property, the Commonwealth shall expend within the limits of such towns, for the purpose of suppressing the gypsy and brown tail moths, such an amount in addition as the superintendent with the advice and consent of the governor shall recommend. Disbursement made by said last named towns in excess of said one twenty-fifth of one per cent shall be reimbursed by the Commonwealth every sixty days; but in the case of all others the Commonwealth shall reimburse cities and towns annually according to the provisions of this act.

No city or town shall be entitled to any reimbursement from the Commonwealth until it has submitted to the auditor of the Commonwealth itemized accounts and vouchers showing the definite amount expended by it for the purpose of this act; nor shall any money be paid out of the treasury of the Commonwealth to cities or towns, pursuant to the provisions of this act, until said vouchers and accounts have been approved by the auditor of the Commonwealth.

For the purposes of this section the years nineteen hundred and five and nineteen hundred and seven shall be considered half years, and the valuation for the year nineteen hundred and four shall be taken as a basis.

Sect. 5. When, in the opinion of the superintendent, any city or town is not expending a sufficient amount for the abatement of said nuisance, then the superintendent shall, with the advice and consent of the governor, order such city or town to expend such an amount as the superintendent shall deem necessary: provided, that no city or town where the assessed valuation of real and personal property exceeds six million dollars shall be required to expend during any one full year more than one fifteenth of one per cent of such valuation, and that no town where the assessed valuation of real and personal property is less than six million dollars shall be required to expend during any one full year more than one twenty-fifth of one per cent of such valuation. For the purposes of this section the valuation of the year nineteen hundred and four shall be used.

Any city or town failing to comply with the directions of the said superintendent in the performance of said work within the date specified by him shall pay a fine of one hundred dollars a day for failure so to do; said fine to be collected by information brought by the attorney-general in the supreme judicial court for Suffolk county.

Sect. 6. The mayor of every city and the selectmen of every town shall, on or before the first day of November in each year, and at such other times as he or they shall see fit, or as the state superintendent may order, cause a notice to be sent to the owner or owners, so far as can be ascertained, of every parcel of land therein which is infested with said moths; or, if such notification appears to be im-

practicable, then by posting such notice on said parcels of land, requiring that the eggs, pupae and nests of said moths shall be destroyed within a time specified in the notice.

When, in the opinion of the mayor or selectmen, the cost of destroying such eggs, pupae and nests on lands contiguous and held under one ownership in a city or town shall exceed one half of one per cent of the assessed value of said lands, then a part of said premises on which said eggs, pupae or nests shall be destroyed may be designated in such notice, and such requirement shall not apply to the remainder of said premises. The mayor or selectmen may designate the manner in which such work shall be done, but all work done under this section shall be subject to the approval of the state superintendent.

If the owner or owners shall fail to destroy such eggs, pupae or nests in accordance with the requirements of the said notice, then the city or town, acting by the public officer or board of such city or town designated or appointed as aforesaid, shall, subject to the approval of the said superintendent, destroy the same, and the amount actually expended thereon, not exceeding one half of one percent of the assessed valuation of said lands, as heretofore specified in this section, shall be assessed upon the said lands; and such an amount in addition as shall be required shall be apportioned between the city or town and the Commonwealth in accordance with the provisions of section four of this act. The amounts to be assessed upon private estates as herein provided shall be assessed and collected, and shall be a lien on said estates, in the same manner and with the same effect as is provided in the case of assessments for street watering.

Sect. 7. If, in the opinion of the assessors of a city or town, anylland therein has received, by reason of the abatement of said nuisances thereon by said superintendent or by said city or town, a special benefit beyond the general advantage to all land in the city or town, then the said assessors shall determine the value of such special benefit and shall assess the amount thereof upon said land provided, that no such assessment on lands contiguous and held under one ownership shall exceed one half of one percent of the assessed valuation of said lands; and provided, that the owner or owners shall have deducted from such assessment the amount paid and expended by them during the twelvemonths last preceding the date of such assessment toward abating the said nuisances on said lands, if, in the opinion of the assessors, such amount has been expended in good faith. Such assessment shall be a lien upon the land for three years from the first day of January next after the assessment has been made, and shall be collected under a warrant of the assessors to the collector of taxes of such city or town, in the manner and upon the terms and conditions and in the exercise of the powers and duties, so far as they may be applicable, prescribed by chapter thirteen of the Revised Laws relative to the collection of taxes.

Real estate sold hereunder may be redeemed within the time, in the manner, and under the provisions of law, so far as they may be applicable, set forth in chapter thirteen of the Revised Laws for the redemption of land sold for taxes.

A person aggrieved by such assessment may appeal to the superior court for the county in which the land lies, by entering a complaint in said court within thirty days after he has had actual notice of the

assessment, which complaint shall be determined as other causes by the court without a jury. The complaint shall be heard at the first sitting of said court for trials without a jury after its entry; but the court may allow further time or may advance the case for speedy trial, or may appoint an auditor as in other cases. The court may revise the assessment, may allow the recovery back of an amount wrongfully assessed which has been paid, may set aside, in a suit begun within three years from the date thereof, a collector's sale made under an erroneous assessment, may award costs to either party and may render such judgment as justice and equity require.

If, in the opinion of the assessors, the owner of an estate upon which an assessment, as aforesaid has been made is, by reason of age, infirmity or poverty unable to pay the assessment, they may upon application abate the same. Every city or town in rendering an account to the state auditor as provided for in section four of this act shall deduct from such amount as it has expended in excess of one twenty-fifth of one percent or of five thousand dollars a provided in said section, the total amount it has received for work performed under section six of this act during the term covered by the account; provided, such work was performed under such conditions as require reimbursement in whole or in part by the State.

Sect. 8. To meet the expenses incurred under authority of this act, there shall be allowed and paid out of the treasury of the Commonwealth, during the period up to and including May first, nineteen hundred and seven, the sum of three hundred thousand dollars. Of this amount seventy-five thousand dollars may be expended during the calendar year nineteen hundred and five; one hundred and fifty thou-

sand dollars, and any enexpended balance of the previous year, may be expended during the calendar year nineteen hundred and six; and seventy-five thousand dollars, and any unexpended balance of the previous years, may be expended during the calendar year nineteen hundred and seven, up to and including May first.

Sect. 9. An additional sum of ten thousand dollars in each of the years nineteen hundred and five, nineteen hundred and six, and nineteen hundred and seven may, in the discretion of the state superintendent, be expended by him for experimenting with parasites or natural enemies for destroying said moths, and any unexpended balance of any year may be expended in the subsequent years.

Sect. 10. Chapter two hundred and ten of the acts of the year eighteen hundred and ninety-one and sections one and two of chapter five hundred and forty-four of the acts of the year eighteen hundred and ninety-eight and section two of chapter fifty-seven of the acts of the year nineteen hundred and two, are hereby repealed.

Section 11. A person who wilfully resists or obstructs the superintendent or an official of a city or town, or a servant or agent duly employed, while lawfully engaged in the execution of the purposes of this act, shall forfeit a sum not exceeding twenty-five dollars for each offence.

Sect. 12. Valuations of real and personal property of the year nineteen hundred and four shall govern the provisions of this act.

Sect. 13. This act shall take effect upon its passage.

(Approved May 8, 1905.

PART III

Gypsy Moth and Brown-Tail Moth Work
1913-1923

Introduction

Late in February 1913 I was advised by Dr. Howard that I was to take charge of the gypsy moth Federal project, March 1. Although this Federal work had been carried on since 1906 when it began with an appropriation of $82,500 and had for its object the prevention of spread of the gypsy moth and brown-tail moth it had been organized in the early years on the basis of supplementing the field work of the State of Massachusetts where the bulk of the infestation by both insects existed at that time. Continuance of spread of the insects and the greater volume of work for its prevention made it necessary to adopt all effective measures that could be devised as rapidly as possible.

A considerable amount of detailed experimental work was started and as fast as new ideas which appeared feasible were conceived they were tried out in the field so that detailed experimental work would form a sound basis for their continued use or modification. The pressing need of relief from the insect, from any source, focused public opinion on the urgent need for importation and liberation of foreign parasites. This work was conducted by cooperation between the State of Massachusetts and the Bureau of Entomology, the former at first meeting most of the expenditures. The results that were secured up to 1913 coupled with the spread of these insects to the other New England States and the desire to reduce expenditures

caused the State forester in 1911 to request the Bureau to take over this work. Every phase of research which appeared promising had been carried on by special assignments of trained personnel to secure accurate answers to many conflicting theories.

In addition to this the great danger of spread by shipment of the insects on forest products or living trees had become apparent as the result of additional small infestations having been reported outside the known infested territory and although these were usually cleaned up quickly by the Federal force it emphasized the danger of widespread establishment of the insect and led to the inspection of shipments by agreement with transportation companies which had been carried on for a number of years under Mr. Rogers' direction. The urgent necessity of Federal inspection of such shipments in order to safeguard uninfested States had long been recognized not only in connection with the gypsy moth and the brown-tail moth but by the spread of many other dangerous pests. The passage of Plant Quarantine Act in 1912 gave the authority necessary and it seemed desirable to centralize the management of the whole project. Perhaps no one realized more than the writer the difficulties and responsibilities connected with this assignment.

The work was taken up with the view of bringing about the closest contact possible with the different types of work that had to be done giving emphasis and support so far as funds would permit to all lines which might contribute to this project and which was of so great importance to the country as a whole. At the time of my appointment it was arranged by Dr. Howard that the quarantine work under the new Plant Quarantine Act should be administered by Mr. Rogers and that

other work which he hadunder way in the infested territory should be handled by him as long as necessary and that Mr. Northley should be in charge of the scouting and treatment work along the outside border of infestation and attend to the eradication of outlying colonies. It was also understood that the research work including the parasite investigations should be directed by myself. These arrangements were satisfactory to all concerned and laid the basis for a harmonious organization. In this way it was possible for the work to be coordinated so that each element could be of mutual assistance to all others not only by the special assignment of men from one activity to another but by free interchange of ideas and discussion of observations that were made either by office or field employees so that they could be given consideration and if deemed practicable put into immediate operation.

The project was set up as a full division of the Bureau. The Federal Horticultural Board promulgated the quarantine and the enforcement was operated by the Gypsy Moth Division and financed from the appropriation of the latter Division.

The Boston headquarters were established at 43 Tremont Street and a small storehouse was rented at Melrose Highlands, Massachusetts. The laboratory continued at 17 East Highland Avenue, Melrose Highlands. In November 1916 the office was moved to 964 Main Street, Melrose Highlands, effecting a substantial saving in rental. (Plates XXVII and XXVIIa) The quarantine section remained in Boston. Temporary storehouses were secured at strategic points to house motor equipment and supplies and on June 1, 1923, a large building was leased at Pittsfield, Massachusetts, which was used as a repair shop and for storage of sprayers, trucks, tools and heavy supplies.

It was necessary to provide for an increased amount of clerical and administrative personnel to meet new conditions which were arising from time to time. Changes in administrative practice in Washington required modifications of the existing system of records so that accurate information might be available to the Chief of Bureau whenever desired.

Personnel

Mr. H. B. Dalton, who had been in charge of the Boston office since the Federal project was begun, was continued in that capacity and assumed many additional responsibilities.

As a result of a cooperative arrangement between the Bureau and the Forest Service, Mr. George B. Clement was transferred from that service to take charge of silvicultural investigations, July 1, 1913 and continued in that capacity until November 30, 1917.

On April 16, 1915, Mr. E. B. O'Leary succeeded Mr. R. S. Clifton as administrative assistant in the Washington office of the Bureau, and the latter was transferred to the Boston office and Mr. Dalton was assigned to the laboratory. April 1, 1919, Mr. Northley was transferred to take charge of the new corn-borer project of the Bureau and Mr. H. L. McIntyre, his first assistant, was promoted to fill the vacancy. On April 27, 1919, Mr. Clifton was transferred to the new corn-borer project of the Bureau and Mr. Dalton was placed in charge of all administrative and clerical duties of this project.

A chart which was prepared in 1922 indicates the set up of the project and was similar to the one from 1913 on, with the exception of the New Jersey project which did not start until 1920. (Plate XXVIII)

The field area was divided into districts with a general foreman in charge and foremen who had charge of individual crews of scouts or laborers. Men below the grade of general foreman were added to the force from time to time. Anyone desiring work was furnished with an application. The requirements were: age 20 to 40 years, good physical condition, ability to walk long distances daily over rough country, and good eyesight.

These applications were filed in the order that they were received and when more men were needed notifications were sent in order to the earliest applicants to report at a designated assembly point which was known as a "kindergartsn". There they were instructed as to the nature of the work, were given tests of their ability to find egg clusters, chop trees, pile and burn brush, climb trees and demonstrate their ability to perform routine tasks required on the work.

If they passed the tests successfully they were hired as laborers at the lowest rate and were assigned to crews under a foreman where additional instruction was given as to the details of the work.

Promotions to a higher grade such as scout or foreman were made, subject to the rules of the United States Civil Service Commission, when there were vacancies. This offered an inducement for the men to become proficient and to learn from field experience the requirements that were necessary in the higher grades. The pay of laborers was increased whey they were assigned to more important duties. Many of our best men holding the higher positions on the project at the present time started at the laborer grade. In the case of men

needed for technical work at the laboratory Civil Service lists were used and those who had had additional training or experience in entomology, of course, were preferred. The nature of all the work on this project was such that it could be carried on throughout the year which made it attractive to men who liked outdoor work. A record was made for the file at the time a man left the service for any reason whatever which included a statement of the grade in which he was working at the time he left and the opinion of the foreman as to his ability and whether his service had been sufficiently satisfactory to warrant re-employment. There are on file at the office records of over 34,000 men who have been in the employ of this project and this data was very valuable after the Federal retirement law was passed as the record of the length of service was readily available.

The outbreak of the First World War in August 1914 which involved Great Britain, France and Russia against Germany and the Austrian Empire not only upset the plans for foreign parasite studies but caused much difficulty in handling the work at home. The appropriations were not curtailed but under war conditions industrial activity, particularly after the United States entered the war, April 6, 1917, was such that there was a heavy loss in trained personnel and extreme difficulty in securing suitable replacements. In addition to this not only the cost of labor increased but sharp price rises in the cost of materials occurred all of which limited the volume of work that could be done. Following this period, business unrest including strikes and freight embargoes in the spring of 1920 prevented purchase and delivery of needed materials for carrying on the work with the greatest efficiency. Sixty men on this project served in the

armed forces during the war, 59 in the United States Service and one in the Canadian Army, and several of them did not return. All service men who wished re-instatement were promptly assigned to their former positions although in some cases men who took their positions had to be discharged.

There were few changes in the official management of the work in the States during the years from 1912 to 1923 except in Maine where Capt. L. E. Philbrick was replaced by Mr. Edward J. Cadey in 1915. Captain Philbrook was later, in 1919, appointed as Deputy Commissioner of Agriculture and Chief of the Division of Plant Industry, with Mr. Melville H. McIntire under his direction as Field Agent in charge of gypsy moth work. In Connecticut, Dr. W. E. Britton retained direction of the work with Mr. Irving W. Davis as supervisor of the field force until July 1, 1918 when the latter enlisted in the United States Marines. He returned to his position January 15, 1919 and resigned for other work June 10, 1920. Mr. J. T. Ashworth, who had previous Federal experience on gypsy moth work joined the Connecticut force June 1, 1917, carried on during Mr. Davis' absence and was placed in charge after Mr. Davis resigned.

The only major change in the personnel of cooperating officials occurred in Massachusetts in 1920 when as a result of a Constitutional Convention, legislation reducing the number of State departments was enacted and Governor Coolidge appointed Mr. William A. L. Bazeley as Commissioner of Conservation and State Forester, succeeding Mr. F. W. Rane in the incumbency of the latter office. Mr. Bazeley announced and immediately placed in effect a policy which discontinued reforestation, roadside thinning and logging operations,

in particular, as part of the State gypsy moth suppression work. Greater emphasis was placed on supervision of the work of the towns and, as a result of the new policy, more funds for reimbursement of towns were available. Mr. Charles O. Bailey, who had been secretary to the superintendent of gypsy moth work since 1907, and continued in that capacity in the office of the State Forester, was retained in the same position. Mr. George A. Smith was continued in direct charge of the State moth work with full authority over his assistants in this work, and Miss Elizabeth Hubbard who had served efficiently since the early years of the State gypsy moth work continued her duties in the office.

Cooperation

It was necessary for this office to maintain relations in cooperation with the various States where work was to be done not only because the right of Federal entry to property had to be authorized by the States or delegated by the responsible State officials, but in order to secure the greatest possible results from the funds appropriated. The existing arrangements were continued and improvements and modifications made by conferences whenever necessary. It has always been the case and still holds that legislation passed by different States aimed to accomplish the same purpose is not identical because it has to be based on the needs and conditions in each State and these vary greatly. It was, therefore, most desirable to establish the practice of cordial helpfulness and mutual assistance whenever it was possible to do so and keep within the bounds of Federal rules and procedure.

It has been recognized for some years that gradual spread of the gypsy moth toward the west and more particularly toward the north and northwest was taking place and in Massachusetts where the bulk of the infestation existed and where the State required town or city management of the work under State supervision that the greatest protection that could be given not only to that State but to all States or parts of States to the west of the known infested area was to have scouting and clean up work carried on by the Federal Government for the protection of outlying territory. This was in line with the purpose of the Federal law to prevent spread of the insects and this policy was followed with the approval of the States, their responsibility being to cooperate so far as available labor or funds would permit on work inside the area handled by the Government. On the other hand, the importation, breeding and colonization of parasites and natural enemies which was carried on by the Government, was equitably shared by all the States concerned and such material made available by the laboratory for liberation in the States where it would be of most value to the project as a whole. The responsibility and expense of enforcing the Federal quarantine also benefited all States, particularly those that were not infested. This resulted in frequent contacts and conferences with the different officials concerned so that it was possible for them to be informed of the latest developments not only along parasite lines but on other phases of the work which would be of interest and value to them. This policy proved most helpful to all concerned and it was possible for the laboratory to obtain much material and needed data from the different States which was invaluable in carrying on the investigations which were under way.

In 1913 arrangements were made with Prof. W. C. O'Kane, State Entomologist of New Hampshire, to assign employees of that State to carry on scouting work in some of the towns along the outside border of infestation which it was impossible for the Federal office to handle with the funds available. During the same year in Connecticut Dr. W. E. Britton detailed State men to spray many infestations in border towns with State-owned equipment which permitted Federal equipment to be used in other areas where the need was very urgent. State cooperation in New Jersey wasoutstanding.

Upon discovery of the brown-tail moth in Vermont in the fall of 1912 the Vermont Legislature passed two bills, one empowering the Commissioner of Agriculture to take charge of gypsy moth and brown-tail moth suppression and the other authorizing the appointment of a state nursery inspectors. Prof. M. B. Cummings of the University of Vermont was appointed State Nursery Inspector. Mr. Harold L. Bailey who was experienced in gypsy moth and brown-tail moth work was placed in charge of insect suppression in March 1913. He took immediate steps to organize this office, cooperate with the Federal moth organization and to instruct the people in the infested towns as to the best methods for combating the pests.

Cooperation was not confined to the States concerned. The Forest Service, the Bureau of Chemistry, the Insecticide and Fungicide board, the United States National Museum and many divisions in the Bureau of Entomology helped in many ways to facilitate the work.

Cooperation was extended by the Bureau to the entomologists of the Dominion of Canada in 1914, when Mr. Burgess journeyed to New Brunswick and Nova Scotia to investigate the brown-tail moth situation

in that area. This trip was made at the request of the Dominion officials who were desirous of receiving expert advice for meeting the situation.

Mention should be made of the friendly interest taken by the public in the Federal work in the outside areas. Where infestation was not severe it was unusual to encounter any obstruction to the work by landowners when the necessity for treatment was fully explained.

Funds

The activities of any project are circumscribed by the funds available. In insect control, prevention of spread or extermination work, the necessities for which cannot be accurately estimated a year or more in advance, ample funds should be provided with the assurance that they will be economically spent.

The appropriations for the fiscal year 1913 to 1920, inclusive, averaged $302,880. During the period from 1913 to June 1919 the average cost per family of twenty-two articles of food was reported by the Bureau of Labor Statistics of the United States Department of Labor as having increased sharply. In Boston, Massachusetts; Fall River, Massachusetts; Providence, Rhode Island; and New Haven, Connecticut the average increases ranged from 77 to 84 per cent, and in Washington, D. C. this increase amounted to 92 per cent.

There was also a substantial increase in the cost for supplies and equipment which made it impossible to carry on as large a volume of work as estimated.

In August 1919 when the estimates were prepared for the fiscal year 1921 an increase of $100,000 was requested for that year which was approved by the Chief of the Bureau, making the total $404,050.

This would make it possible to increase the pay of labor and to take care of the increases in salaries which had been authorized by Congress in the period from 1917 to 1919 aswell as to cover additional scouting and treatment work necessitated by the finding of small infestations that had been discovered in the previous year.

Recommendations were made by the Secretary of Agriculture for an appropriation of $304,050, which was the same amount made available for the fiscal year 1920, and then in a general move for economy during this post-war period Congress appropriated only $250,000. This money was available July 1, 1920 and early in that month a heavy infestation was discovered in Somerville, New Jersey by the State Nursery inspectors. The situation was so serious that immediate action had to be taken and men were transferred from the New England area to determine the size of the problem which had to be met and only a limited amount of work could be done in the latter area for the balance of the fiscal year. The State of New Jersey took action and as the Legislature was in session in the fall of 1920 an appropriation of $112,000 was made and in March 1921 Congress appropriated $225,000 to meet the emergency.

In the fiscal year 1922 although estimates called for an appropriation of $600,000 only $400,000 was made available. During the year the additional scouting in New Jersey made it possible to determine the approximate size of the problem in that State. The estimates for 1923 called for $600,000 and this was passed by Congress with a provision that $100,000 of this amount be made available for use in the previous fiscal year.

The continued spread of the gypsy moth, which was due largely to the lack of sufficient funds and the necessity of labor replacements,

which involved the training of many new men, together with the discovery of the most serious outside colony that had ever been found, presented a most difficult outlook, although the early work that was done in the New Jersey area was encouraging and it was thought that with continued State cooperation, sufficient funds and well trained and competent men, the insect could be exterminated after a period of years.

A full account of the management and results secured on the New Jersey project is treated separately at the close of the period 1913-1923.

Publications

From time to time during this period bulletins were published for the information of the public which indicated the improvements and changes that had been made in the work. Posters giving information were used for the same purpose and moving pictures and some lectures were given before scientific societies and other organizations usually at their own request. No attempt was made to use high pressure publicity methods but the interest and opinions of experts in the different States who had an opportunity of visiting the offices or the laboratory and discussing the problem and existing conditions created a very favorable impression.

Field and Laboratory Research

Parasites

Continued emphasis was placed on the parasite work at the laboratory and close cooperation was maintained with the several States for the purpose of liberating and colonizing the different species to the best advantage. Both Maine and New Hampshire established small

laboratories in 1913 with facilities for rearing and colonizing parasites, arrangements were made with the Dominion Entomologists of Canada to cooperate in supplying and shipping parasites to New Brunswick and Nova Scotia where the brown-tail moth had become established, and full reports of the parasite investigations continued to be furnished to the Massachusetts State Forester annually.

No parasites or parasitized material was imported from either Europe or Japan in 1913 but Dr. J. N. Summers travelled to Europe in the spring of 1914 to continue earlier studies of foreign parasites in relation to their native behavior. Extensive search throughout Germany revealed an almost complete absence of large gypsy moth infestations but in Hungary large tracts of defoliated woodland were reported and observed. Attempts were made to arrange for collection and shipment of parasitized material from Hungary to the United States but the First World War, which broke out in August 1914, caused abandonment of these plans after Dr. Summers returned in September.

Large numbers of the apparently successful egg parasites, Schedius Kuvanae and Anastatus bifasciatus, were reared, both species were colonized and most field collections showed abundant establishment. Although many colonies were placed in Massachusetts, Connecticut and Rhode Island, the bulk of the numbers released were colonized in Maine and New Hampshire by State employees at colony sites selected by Federal laboratory workers. In the spring of 1914 there were liberated 1,561 colonies of Anastatus, of 1,000 individuals each, and in the fall 2,000,000 individuals of Schedius were liberated in 500 colonies. The following spring nearly 10,000,000 individuals of Anastatus were colonized. Liberations were continued

and recoveries were made in very encouraging numbers until after the very severe winter of 1917-1918 when evidence of widespread winter killing was observed especially in Maine and New Hampshire. Attempts were made the following seasons to re-establish both Schedius and Anastatus but it was increasingly obvious that the latter in particular was not capable of withstanding the winter climate at the northern range of the gypsy moth.

The tachinid parasites, Compsilura concinnata and Blepharipa scutellata, continued to be recovered in good numbers and over wide areas of the gypsy moth infested area. All parasites received a setback in the winter of 1917-1918 but appeared to become re-established later. Compsilura was the subject of the United States Department of Agriculture Bulletin No. 766, "A Study of Compsilura Concinnata, An Imported Tachinid Parasite of the Gypsy Moth and the Brown-tail Moth", by Julian J. Culver, published on July 10, 1919.

The predaceous beetle, Calosoma sycophanta, was found to be very abundant year by year over an ever increasing range and was very destructive to the gypsy moth caterpillars and pupae, especially in the more heavily infested areas. This insect and the American members of the same genus were carefully studied, the results of which were published on July 27, 1915, as a professional paper in the United States Department of Agriculture Bulletin No. 251, "The Calosoma Beetle in New England", by A. F. Burgess and C. H. Collins, which is a report in detail of the life history, dispersion, economic importance, and development of methods for rearing and colonizing the insect. This publication was followed on July 25, 1917, by the same authors, of the United States Department of Agriculture Bulletin No. 417, "The Genus Calosoma".

Every effort was made to improve and refine the laboratory technique employed in breeding and rearing parasites and very good results were achieved, for example, in the case of Apanteles melanoscelus, a most important parasite of the gypsy moth in Italy, by devising a more efficient breeding chamber. This parasite was first sent to this country in 1911 by Mr. Fiske and has become increasingly abundant. The brown-tail moth parasites, Apanteles lacteicolor, Meteorus versicolor and Zygobothria nidicola, were recovered each year but the numbers varied in proportion to the abundance of its main host.

Research work at the laboratory was reduced somewhat, in keeping with the other sections of the project, mostly on account of the inability to secure sufficient funds upon which to plan any expansion of the program. Nevertheless, experiments and observations were not neglected in any direction. Collections were made, data were secured and results were noted on the abundance and effect of parasites. They continued to be found well established throughout New England and in large numbers in many localities, but not in sufficiency for a reasonable measure of control by themselves alone. Colonization of several species was continued, particularly where plantings had not been made in previous years.

In 1922 plans were made to resume the foreign parasite investigations which were interrupted by the First World War in 1914. Dr. J. N. Summers was detailed to Japan and Mr. S. S. Crossman went to Europe in the spring of the year 1922, for the purpose of surveying the regions infested by the gypsy moth, studying the insects in their native habitats, and collecting for shipment to the United States as large a number of parasites as possible. Some material was collected but not in

any appreciable quantity the first season. These trips were of most value in that they laid the groundwork for continuation of the foreign work in the years following, in order that a complete knowledge of future usefulness of parasite introduction might be correctly evaluated.

Studies on two species of parasites at the laboratory were brought to publication in 1922 in United States Department of Agriculture Bulletin No. 1028 by S. S. Crossman, "Apanteles melanoscelus" and Bulletin No. 1008 by C. F. W. Muesebeck, "Zygobothria nidicola, an Important Parasite of the Brown-Tail Moth."

Diseases of the Gypsy Moth and the Brown-Tail Moth

Most of the research work and dissemination of diseases of the gypsy moth and brown-tail moth were carried on under the direction of the State Forester of Massachusetts and the results that were secured have already been discussed in this report. Great reliance was placed by him on artificial culture and dissemination of the wilt disease which attacks the gypsy moth and some native caterpillars. The work was carried on by Mr. William Reiff assisted by the division superintendents and local moth superintendents in the State. Careful research was later carried on by the Bureau of Entomology by arrangement of Dr. Howard with Dr. W. M. Wheeler at the Bussey Institution of Harvard University and Dr. R. W. Glaser and Dr. J. W. Chapman were assigned to investigate carefully the status of this disease in cooperation with the Federal gypsy moth project. A preliminary report of their work was published in the Journal of Economic Entomology, Volume 6, Number 6, 1913, which indicated that it was not wind-borne and could not be spread in that way artificially, and showed conclusively that the methods of

dissemination that were being used were of slight value. This disease occurs in most sections of the infested territory and appears to be a filterable virus rather than a malady caused by bacteria. It sometimes causes heavy reduction in the gypsy moth caterpillar population, particularly in areas of heavy infestation and serious defoliation, where food is scarce and malnutrition and starvation of the caterpillars occur. (Plate XXIX)

A fungus disease of the brown-tail moth, Entomophthora aulicae Reich., which attacks both small and large caterpillars and which turned out to be a native species was also investigated at Mr. Kane's suggestion by members of the research staff of Harvard University. In some years it has caused considerable mortality of the larvae but is not a dependable control agent.

Food Plants and Observation Points

The work on food plants was begun at the laboratory in 1912 by feeding gypsy moth caterpillars in different stages on the foliage of different species of trees. This work required great care and patience and from year to year the results were checked with data secured from the observation points of the feeding habits in the field of the larvae on the same species of trees.

This made it possible to compare the results under different conditions and the combined data was brought together and published as a Department of Agriculture Bulletin No. 250 entitled "Food Plants of the Gypsy Moth in America", by F. H. Mosher. The methods used, plants tested and the results attained with caterpillars in different stages of their development made is possible to arrange the different species of trees into four classes based on the food preference of the larvae

in the different stages. Class I included trees favored by all stages of the larvae: Class II, species not favored by the early stages of the larvae but freely eaten by the later stages: Class III, species not particularly favored but upon which some larvae will develop; Class IV, unfavored species. In cases where the infestation is heavy defoliation usually occurs on all species except the most resistant in Class IV.

The conclusions reached concluded a valuable piece of research and the results have been applied on field operations with great benefit to the project. Following the time of the publication of this bulletin some additional observations have been made and the work had been checked by many observers and the results, with only a very few border-line cases, have proved to be accurate and extremely useful.

In addition to collecting data on the feeding habits of the gypsy moth in the observation points, information was gathered each year on the mortality or injury to different species of trees as a result of feeding by the larvae, the condition of the trees which indicated the injury caused, and the effect on the rate of growth which was taken after a considerable interval of time. Some of the data was published under the title of "Some Results of the Defoliation of Trees" in 1925 by C. W. Minott and I. T. Guild in the Journal of Economic Entomology, Volume 18, P. 345.

It was necessary that these observations be made over a long period of time in order to determine the effect of seasonal conditions and other variable factors on the growth of trees.

Data relative to parasitism and disease aswell as the effect of the weather on hatching or mortality of the young larvae was also secured so that a large volume of valuable data was obtained for in-

tensive study and interpretation. From time to time special data was secured so that the additional information could be applied in the field work.

A considerable percentage of the points selected was rendered worthless due to the cutting of trees by the owners of property which constantly modified the mixture of species in the points concerned and so seriously affected the value of the data that a large number of points had to be abandoned.

The Gypsy Moth as a Cranberry Pest

Prior to 1915 and extending up to about 1921 serious damage was caused to cranberry bogs in the Cape Cod section of the State of Massachusetts. This is a specialized industry, the principal sections of the United States where this crop is grown in large commercial quantities being confined to certain areas in Massachusetts, New Jersey, Wisconsin, Oregon and Long Island, New York. It requires special handling as well as considerable expense for cleaning and putting land into condition to successfully grow the plants and in addition an adequate water supply must be readily available to use for flooding the bogs for protection of the plants particularly from frosts early in the spring. (Plate XXX) Complaints of serious damage and loss caused by the larvae feeding on the new growth which curtailed the future crop made necessary the use of preventive measures and the State Forester's office was interested in this problem and cooperated with the growers in preventive work. (Plates XXXa and XXXb) Special studies of these larvae were made by Dr. H. J. Franklin, Director of the Wareham Cranberry Sub-Station of the Massachusetts Agricultural Experiment Station during this period and were published in Bulletins 160, 180, 192 and 206 of that station. Mr. C. W. Minott of this Bureau collaborated

with him and published his data in United States Department of Agriculture Bulletin No. 1093 entitled "The Gypsy Moth on Cranberry Bogs" in 1922. The results indicated in these publications have made it possible for the cranberry growers to protect their crop from the gypsy moth at a reasonable expense.

Dispersion of the Gypsy Moth

The theory of wind dispersion, which seemed to be the logical reason for much of the spread of the gypsy moth to new infested territory, was carefully explored by means of field and laboratory research and the results were published in United States Bureau of Entomology Bulletin No. 119, "The Dispersion of the Gypsy Moth", by A. F. Burgess, February 11, 1913. This bulletin drew definite conclusions but additional experiments were conducted under varied field conditions in more localities within the gypsy moth area. The results of these experiments were published on August 24, 1915, as a professional paper in United States Department of Agriculture Bulletin No. 273, "Dispersion of Gipsy-Moth Larvae by the Wind", by C. W. Collins. The paper explained the scope of the investigations and indicated that the wind was almost wholly responsible for general spread of the insect in New England.

So far as the gypsy moth is concerned experience backed by field scouting records indicate that as a rule small gypsy moth larvae that are borne in the air tend to scatter in different directions from points of heavy infestation, and re-infestation by this means is usually more heavy at short distances from the point of their origin. (Plate XXXI) The absence of food in the areas to which they drift

means eventual starvation and if they are deposited in locations where the food is unfavorable this controls their chances for establishing the species. Long distance spread must result from a tremendous number of small caterpillars being borne by air currents that move in rather fixed directions. Otherwise the scattering would be so great that many will fail to reach favored food in sufficient quantities to establish a new colony. There is no question but that tremendous numbers of small caterpillars are borne in this way any year when weather conditions are favorable, also that the bulk of the small larvae do not survive. Nevertheless the survival of a small portion of those that are blown has contributed the most important factor in natural spread of the insect.

Gypsy Moth Tree Banding Material

Among methods for preventing defoliation and destroying gypsy moth caterpillars was the wide use of tree banding materials. For many years burlap bands were used but had the disadvantage of requiring periodic attention. Tanglefoot was also applied to the trees and gave satisfactory results. Many substitutes for these materials were tested but none were fully effective. In a serch that was made for other means to use against the caterpillars a material was imported from Europe which gave promise that it would be effective and reduce the cost somewhat. After preliminary tests had been made in the field, laboratory tests were undertaken and experiments were carried on in cooperation with the United States Bureau of Chemistry to devise a formula for a more satisfactory banding material that could be manufactured and sold at as low a price as possible. After several years of testing and checking results four tons of this formula which was known as Gypsy

Moth Tree Banding Material was prepared and used in the field with good results. (Plates XXXII and XXXIIa) For several years this material was prepared by the project in large quantities and used in the field. The details were published in United States Department of Agriculture Bulletin No. 899, "Gypsy Moth Tree Banding Material", by C. W. Collins and C. E. Hood in 1920 and gave full directions for preparing and applying the material for gypsy moth control. Several attempts were made to induce manufacturers to make and put this material on the market but few of them showed very much interest as they did not believe there was sufficient demand for the material to warrant manufacturing it on a large scale.

Mortality Due to Weather

Weather is a prime factoryin reducing gypsy moth infestation and owing to the extreme variability of climatic conditions in the New England States it is practically impossible to predict in advance the role it will play in any year. It affects particularly the insect in the egg and early larval stages. When it is realized that the gypsy moth exists in the egg stage throughout practically nine months of the year the hazard as to the rate of increase of the pest from year to year is difficult to foretell. This was demonstrated strikingly as the result of the work carried on in the observation points where one of the prime factors which was considered at the time these points were established was to determine the increase of egg clusters that would result from year to year in order to build up caterpillar population sufficiently large to cause heavy defoliation.

Weather was one of the factors which could not be forecast as having a predictable bearing on the population the following summer.

It was first thought that a temperature of 20 degrees below zero killed all eggs in a cluster unless they were protected during the period of the lowest temperatures by being covered with snow or ice, or deposited in cavities or other situations where this degree of cold was not effective. Weather observations indicated in some localities that occasionally clusters hatched wholly or in part when the temperature for the locality registered somewhat lower and it was later concluded that 25 degrees below zero was a safe index for mortality unless natural protection existed. Snow cover during the winter varies greatly due to the contour of the country when deep snow and minimum temperature may be coincidental the great difficulty of setting a standard of determining the probably hatching based on temperature alone, or of making a rule relative to height of snow-line which will give egg clusters winter protection will be appreciated. Furthermore, as many of the eggs are laid on the trucks and under sides of branches of the trees and these are coated periodically with ice or snow the mortality except in individual cases where continuous observations are made throughout the winter is almost unpredictable. This is the reason why in 1924 a change was made in taking data. Observations from practically all the roads in the territory as to the degree of defoliation during the summer were secured as an index of abundance and damage caused by the insect. Hatching of the eggs is also controlled by the temperature and varies from year to year. Iftemperatures are high for a limited period, hatching will take place as early as April 15, sometimes before that date, while in other years it may not occur until May 1 or even as late as the 10th of that month, all of which is based on temperature. A great hazard, however, after the small larvae hatch is due to extreme fluctutations in temperature which either

stimulate activity of the small larvae after they emerge from the eggs and are searching for food or retard their activity and cause their death if the temperature is low for an extended period. Furthermore, hatching of the larvae is closely correlated with the development of the buds and small leaves which furnish their food and heavy frosts which cut down the foliage and which frequently occur locally may cause most of the caterpillar population to die from starvation. In some sections of the territory thousands of acres of woodland are sometimes defoliated by frost in the early growing season. Extended periods of rain accompanied by low temperatures in the spring, even if frost does not occur, prevent the caterpillars from feeding and developing and considerable mortality results.

The effect of snow and particularly ice when there is a heavy coating on the trees frequently causes breakdowns of limbs and sometimes splits the trunks so that while the trees are not killed many of them are rendered worthless but produce foliage on which the caterpillars can feed and render scouting work difficult and costly. Some of these conditions may occur locally almost any year and have a striking effect on the population or increase of the insect and complicate the problem of control or extermination.

Some mortality of eggs also results from attack by egg parasites but Anastatus which passes the winter within the egg may also be killed by extreme cold. Schedius which is multiple brooded has not developed satisfactorily under weather conditions in the colder portions of the New England Territory.

In the winters 1917-1918 and 1919-1920 the weather was so severe both as to temperature and heavy snowfall, particularly in the northern

sections of the territory where work had to be done, that the scouting force was used for a part of the winter in the southern sections where such severe conditions did not exist.

Advantage has been taken of weather bureau records and sometimes temporary weather station data has been used as a basis for collecting egg clusters in different sections of the territory to determine prospective areas for spraying. During some years spraying is seriously interfered with in June by prolonged rain and if airplanes are used for spraying these conditions or unfavorable winds reduce their flying time for effective operation.

Bulletin No. 1080, "Effect of Low Temperature on the Hatching of Gipsy Moth Eggs" by Dr. J. N. Summers was published in 1922. This publication is a detailed report of studies begun shortly after the extremely cold winter of 1917-1918 when the abundance of egg parasites was so adversely affected by the winter killing of the gypsy moth eggs.

Effect of Weather on Brown-Tail Moth

The wind is a prime factor in the dispersion of the brown-tail moth and doubtless was responsible for the rapid spread of this insect toward the north and northeast into Maine, New Hampshire and Vermont whenever conditions were favorable at the time the moths emerged. Both males and females fly freely so that new colonies could be started without difficulty wherever females found lodgment. In addition to this both sexes are attracted strongly to bright lights and this accounted for many colonies becoming established in cities and towns which were well illuminated at night. (Plate XXXIII)

The small caterpillars in the brown-tail webs which are attached to the small branchesoor leaves of the trees are protected during the

winter by the silk of which the web is composed. Within the web the caterpillars are protected by a special envelope of silk which is spun around their bodies or by groups of these small webs which become attached to each other if the caterpillars are crowded at the time the spinning of the web occurs. These webs are the favorite place for the hibernation of various small insects and some species of small parasites frequently inhabit them during the winter. Extremely cold weather sometimes causes high mortality of the hibernating caterpillars and this is particularly true in the most northern part of the infested territory and assists in reducing the increase of the species in unfavored localities. Several of the imported parasites attack the small brown-tail caterpillars before the webs are spun and the larvae of these parasites live within the small caterpillars during the winter. In cases where the caterpillars are destroyed by cold weather the parasitic larvae are also killed and some of the species not only attack the gypsy moth but other native caterpillars the loss resulting from their death reduces the abundance of these beneficial species.

Silvicultural Work

Plans have been made in 1912 for studies in cooperation with the United States Forest Service in respect to the relation of proper forest management to the control of the gypsy moth. Silvicultural control had been discussed and in fact selective thinning had been practiced by the Bureau in the outer band of territory in which it was operating, based on knowledge gained by observation of the feeding habits of the insect. In Massachusetts the State Forester, Mr. F. W. Rane, stressed this phase of the control work and advocated the theory that it was the only proper approach to the gypsy moth problem in

woodland. After Mr. Kane had been in office a few years he expressed the desire to have the people of Massachusetts enthused with reforestation and modern forestry methods to make "the State a veritable Black Forest from the tip of Cape Ann to the Town of Mount Washington, from the summit of Greylock Mountain to Provincetown and the islands of the sea." It was finally arranged for the assignment of a forester to the Federal moth project acting under direction of the Forest Service to undertake a comprehensive silvicultural research program. Mr. G. E. Clement was assigned to this work by the Forest Service and after the experiment got under way he was transferred to the Bureau of Entomology payroll and Mr, Willis Munro, a trained forester, was employed as his assistant. As many as six field assistants were employed to supervise the field plots. The work was financed principally by the Federal gypsy moth project.

For the purpose of the silvicultural investigations 29 sample plots were laid out in Maine, New Hampshire and Massachusetts. The plots increased in number by 1915 to 46, covering 151.75 acres, and were thinned and treated according to accepted forestry practices and in some cases they were underplanted at the expense of the owners with the idea of conforming the resultant forest to control of the gypsy moth. (Plate XXXIV) In the fall of 1913 Mr. Kane returned from a trip to Germany where he had visited the Black Forest. An attempt was started the following winter by Mr. Kane and Mr. Clement to interest the people of Winchendon, Massachusetts, in duplicating the German Black Forest in Winchendon woodlands. Surveys were made by representatives of the State Forester's office and the Bureau. This proposal met with approval on the part of local citizens and woodland owners but they were unwilling to finance the operations, and neither the

State Forester's office nor the Bureau had available funds to operate such an extensive program.

Mr. Clement's experiments were continued and in 1915-1916 assembling of data was started for determination of the best methods of utilizing the wood from plants which are favored food of the gypsy moth and which for that reason should be eliminated. This study was proposed to provide a stimulation for voluntary cooperation on the part of woodland owners in the thinning phase of the gypsy moth control program by pointing out the possibilities of more profitable markets for the thinned out wood products. Under date of April 9, 1917 the United States Department of Agriculture Bulletin No. 438, "Control of Gipsy Moth by Forest Management", by Clement and Munro was published as a professional paper jointly by the Bureau of Entomology and the Forest Service. Later in the fall of 1917 added interest in the use of cordwood as fuel was aroused due to coal shortages on account of the First World War and a paper was published by the Bureau entitled "Some Timely Suggestions for the Owners of Woodlots in New England", by F. H. Mosher and G. B. Clement. At about this time further studies of the silvicultural investigations were interrupted by the resignation of Mr. Clement from the Federal service on November 30, 1917.

Mr. Munro continued the routine work in connection with the plots and also spent a considerable portion of his time in making a study of cordwood and the utilization of materials which would result from silvicultural thinnings. An annual survey of the plots was made relative to defoliation and condition of trees by Mr. Irving T. Guild from the laboratory and after Mr. Munro resigned on December 31, 1940 this part of the work was continued by Mr. Guild who also secured other information

relative to the plots and collaborated with Mr. C. W. Minnott who had charge of the work on the observation points.

With the abandonment of the silvicultural project at Winchendon the State Forester continued his efforts to interest owners of woodland to put into operation a system of forest management at their own expense for the purpose of controlling the gypsy moth. Plans for operation of the woodlots and supervision of the work were furnished by the State and advice was also freely furnished. Assistance was made available in finding markets for lumber and other wood products in anticipation that the price of the material cut would be sufficient to meet the cost to the owner and give some profit, in addition to furnishing protection from the gypsy moth after the operation was completed. For a few years this plan was operated which resulted in considerable additional expense for personnel to the Forestry Department.

Over 500 areas were examined during the period from 1913 to 1919 and over 120 lots including 6,000 acres were treated in this way. The State Forester's annual reports from 1914 to 1919 indicate some margin of profit in most cases but on many of the lots the money values were estimated after cutting rather than on the cash received at the time of sale. During the war period the price of all wood products was abnormally high but later in many localities the market was overstocked and profitable sale was very difficult. In the case of cordwood the demand was very slight. As previously stated, in 1920 when the Department of Forestry was reorganized, this project was discontinued by the new management and an attempt was made to use the funds saved to reimburse the poorer towns so that more direct gypsy moth work could be done. Some owners followed up the idea of selective thinning although the acreage treated was relatively small.

Secondary Insect Investigations

During the summer of 1912 many large woodland areas north of Boston and extending into southern New Hampshire were completely defoliated. Most of these trees refoliated in July but later in the summer the new leaves withered and whole hilsides at a distance presented a brown instead of a green appearance. This was the work of a small beetle known as Agrilus bilineatus (Web) which is more commonly known as the two-lined chestnut borer, whose larvae channeled the tissue underneath the bark. It had always been considered that this species attacked chestnut trees rather than other tree growth, although it sometimes attacked oak trees. Many of these trees died during the winter and Dr. A. D. Hopkins, in charge of Forest Insect Investigations of the Bureau was consulted, as one of the purposes of the silvicultural work was to attempt to use the red oak in the plan of forest management.

Later an arrangement was made whereby Mr. H. L. Preston was detailed to carry on such experimental work as seemed necessary under the direction of Dr. Hopkins and a number of special plots were selected and kept under observation. In March 1913 an arrangement was made whereby the salary of Mr. Preston and additional employees of this project would be paid from gypsy moth funds and the former would carry out detailed instructions and report to Dr. Hopkins on the observations that were made. Dr. F. C. Craighead made several visits to the territory to determine the progress of the work. Toward the close of the fiscal year 1914 some conclusions were drawn which indicated that cutting and burning of the infested trees before the beetles emerge in the spring was an effective method of procedure and could be adopted by any woodland owner who was willing to bear the expense of so doing.

The question as to the continuance of this investigation was given consideration and Dr. Hopkins proposed that $12,000 should be allotted to Forest Insect Investigations by the gypsy moth project for a continued study of all forest insects in the New England territory to be administered exclusively under his supervision for field and laboratory salaries and travel and the use of an existing laboratory near Washington, D. C. This proposal and the allotment of so large a portion of the gypsy moth funds did not seem warranted, particularly as a laboratory already existed at Melrose Highlands, Massachusetts, where it was believed that the work could be advantageously conducted and at less expenditure of funds. Willingness was expressed to continue cooperation so far as Agrilus was concerned on the same basis as during the previous fiscal year provided additional funds were made available which were already carried in the estimates for the gypsy moth project to provide for additional gypsy moth work. This increase was not appropriated and the work was discontinued.

Although widespread and intensive defoliation has existed throughout the eastern part of the infested area during many seasons since that time and an abundance of all species of oak have been severely defoliated by the gypsy moth and the mortality of the trees has been so high no similar outbreak of Agrilus has been reported and this would seem to indicate that other factors which were not well understood entered into the problem during the year when this heavy outbreak occurred.

The Brown-Tail Moth

Federal work on the brown--tail moth so far as clean up operations were concerned were, except in special areas, carried on as a part of the gypsy moth project. All of the States, however, were active in

carrying on this work, particularly in the residential sections as neglect to do so caused vigorous complaints by owners and tenants of residential property.

The work of inspecting trains each summer during the night to determine whether the insect was carried by this means and to destroy any that might be found was continued and in July 1914, during the moth flight, 2,227 moths and two egg clusters were found and destroyed which was the largest number ever taken in a single season. The flight the following year was less abundant and only 89 were taken on railroad trains and none were found at lighthouses. In 1916, 78 moths were captured on trains, many of these being males, and as the intensity of the flight diminished in succeeding years this work was discontinued.

The work in the State of Vermont should be particularly mentioned as from the time legislation was passed by the State in 1912 the work was centered on the brown-tail moth, most infestation being found in the towns along the Connecticut River. Assistance was given by the Federal force on this work and an effort was made by both forces to instruct the people and encourage them to remove and destroy the winter webs of the insect. Some scouting was carried on around the outside border of the infested area for the purpose of relocating the quarantine line.

In 1921 ten towns were released in New Hampshire and in 1922 additional towns were released so that by the end of the fisca l year July 1, 1922 the quarantine had been removed from Vermont, Connecticut and Rhode Island as well as from a section on the east end of Long Island, New York and the area had been reduced 67 per cent from the maximum spread in 1914 of about 38,000 square miles. Practically

all the clean up work in New York had been done by the State Department of Farms and Markets. The greatest diminution of territory, however, was in the northern part of the territory in Maine and New Hampshire were excessively low temperatures in the winter caused great decrease in the abundance of the pest in contrast with the conditions that existed in 1914. This encouraged the hope that by proper organization and sufficient funds and by taking advantage of natural factors this insect could be eliminated but conditions were such in the period following the war that there seemed no opportunity to begin such a project.

Scouting and Treatment

In August 1912 Mr. G. G. Atwood, State Nursery Inspector of New York, advised that a small infestation of the gypsy moth had been discovered in Geneva. This was the most westerly point in the United States where the insect had been found up to that time. The State Department of Agriculture took prompt measures to stamp out this infestation by treating the egg clusters and cleaning up and burning all rubbish in the area where the insect was found. During the following winter Federal scouts examined the entire area and only two new egg clusters were found which were promptly treated. During the next winter a further examination was made without finding any trace of the insect and the section of the city of Geneva nearest the infested locality was thoroughly scouted also with negative results.

In February 1914 a number of experts who were pruning trees on an estate in Bratenahl, Ohio, a suburb of Cleveland, discovered several egg clusters of the gypsy moth and immediately notified the Federal gypsy moth office in Massachusetts. These men had had considerable

experience in that type of work and as they had operated in territory near Boston they were familiar with the insect. An investigation showed that their determination was correct and contact was immediately made with the State Nursery Inspector of Ohio, Mr. N. E. Shaw, who visited the estate and plans were made to clean up the infestation. This work was done jointly, some men beging detailed from the Ohio State inspection force. Additional egg clusters were found and treated but the area where the insect was spread covered only a small acreage. Nevertheless a wide surrounding area of approximately two square miles was carefully inspected to make sure that there had been no spread from this infestation. Careful spraying was done in the center of the infestation, part of the men, the spraying machine and equipment being furnished by the Federal office while the remainder of the force and the necessary insecticides were supplied by the State. Treatment of this area gave very satisfactory results as no new egg clusters were found the following summer.

Early in the fall of 1914 a report was received that several carloads of stone which originated at Billerica, Massachusetts, had been shipped to an adjoining estate in Ohio. It seems that the owner while making a trip through eastern New England conceived the idea that it would beautify the estate if a typical New England stonewall could be built on a part of the property. He accordingly purchased several old stonewalls made up of boulders which were well weathered and shipped them by freight to the Ohio estate. After the shipment left Massachusetts, the news of its having been sent was reported to the office and the Ohio State Nursery Inspector was notified. An examination brought out the fact that the stones were unloaded and hauled to the

estate a distance of a mile or more and the wall constructed. A few egg clusters were located and treated by the State force and a careful examination made of the ground and the trees along the route where the stones had been hauled. As a precaution the following spring tree growth near the wall was inspected and thoroughly sprayed as well as all trees protecting the road over which the stones had been moved and the trees near where the unloading had been done. This method of handling the problem worked out very satisfactorily and no further infestation has been discovered on the estate or the surroundings since that time although several check up inspections were made in the years that followed. This infestation is the most westerly that has ever been found in the United States and it was particularly important that prompt and effective measures be taken speedily so that no chance of development or spread of the pest would result. In view of the fact that the quarantine covered only plant products the movement of stone was exempt from the quarantine restrictions but action was immediately taken so that the quarantine was amended making it necessary for stone and quarry products to be inspected and certified before they could be moved from the quarantined territory. The cooperation which was secured from the State Nursery Inspector was excellent and every means was provided so that this infestation was given thorough and effective treatment.

In May, 1914 a well established colony of the gypsy moth was discovered in Mount Kisco, which is in the town of North Castle, Westchester County, New York. Careful scouting was carried on and it was found that the infestation covered about one half square mile and over 3,000 egg clusters were found and treated before hatching began

in the spring. The area was intensively sprayed, also a protective band surrounding it. The work was carried on in close cooperation with the State Department of Agriculture. As a part of this infestation was in woodland some thinning was necessary which was carried on in the fall in order that the area might be carefully covered the following spring.

In August, 1914, Dr. T. J. Headlee, State Entomologist of New Jersey, reported that a male gypgy moth had been taken at a street light in the town of Rutherford, New Jersey, and requested that Federal scouts be assigned to make an examination. The identity of the specimen proved to be correct and on a thorough examination of the area in the fall several old and a few new egg clusters of the insect were found in a small nursery near the place where the moth was taken. The area was sprayed by State employees early in the summer of 1915 and a complete check on the shipments made from the nursery to determine so far as possible if any material had been sent out which was liable to be a source of further spread. The nursery was thoroughly examined together with over ten square miles of surrounding territory and no additional infestation was found.

In the winter of 1915-1916 Federal scouts made a careful examination of the entire park system of Rochester, New York, on the suspicion that infested nursery stock might have been shipped from New England but no trace of the insect could be found.

In addition to this work in cutside colonies the old colonies that were found in Great Barrington and Lenox, Massachusetts were thoroughly re-inspected but no infestation was found and in the summer of 1916 it was determined that all of these infestations had been

exterminated with the exception of the one at Mount Kisco where isolated egg clusters were found and these were promptly treated and additional spraying applied. No evidence of infestation has since been discovered, although repeated examinations have been made.

About July 1, 1920 it was reported that small infestations were found in Prospect Park, Brooklyn, New York. Although too late for effective spraying the infestations were treated by employees of the Park Commission and later the area surrounding the infestations was examined by Federal scouts. Late the following spring the infestations were sprayed cooperatively by the Brooklyn Park Department and the State Department of Farms and Markets.

In 1921 new colonies were found on Long Island, New York at Greenport in June and at Patchogue in July. These were thoroughly treated and after several re-examinations no trace of the insect could be found.

The amount of scouting performed varied from year to year largely on account of unfavorable weather conditions in the winter but on the average the roadsides and woodlands of about 200 to 250 towns were examined and infestations treated each year. Spraying operations were conducted on as large a scale as possible with increased acreages totaling 3,167 in 22 towns during the season of 1920. This does not include the scouting and treatment work done by the States and towns inside the border for their own protection and incidentally for the purpose of preventing wind spread to the border towns or to territory beyond.

The inability to secure well trained men as replacements during this war period seriously affected the quality of the work and the

amount of acreage that could have been covered by more competent employees and the supervision was affected somewhat as the result of abnormal conditions.

In 1916, 35 tons of arsenate of lead were used and the spray was applied by 13 high power spray units, one of which was powered by a truck motor.

In the winter of 1917--1918, which was marked by extremely low temperatures and deep snowfalls, scouting revealed a considerable increase in the infested territory, nearly half of which was found in Maine. The following season of 1918-1919 was favored with a mild winter and conditions were more nearly ideal for scouting and treatment work. As a result of the concentrated efforts of the field force and due no doubt to a great amount of winter killing of egg clusters the previous year it was possible to reduce the quarantined area to 20,747 square miles by releasing 52 towns found to be free from gypsy moth infestation from the western border of the infested territory.

On the other hand, on account of the mild winter and spring in 1919 few egg clusters failed to hatch, parasites were scarce, particularly the egg parasites which failed to withstand the severe winter of 1917-1918, and the winds were favorable to cause extraordinary spread, mostly from the heavily infested sections of Maine, New Hampshire and Massachusetts, of newly hatched caterpillars during May and June 1919 so that scouting in the following winter of 1919-1920 revealed scattered infestations over an area of 25,316 square miles.

The necessity for prompt action when the infestation in New Jersey was discovered in the summer of 1920 made necessary the transfer of the scouting force from the border work in the New England area so that only a minimum amount of scouting was possible during

1921 and 1922. Small scattering infestations were found and treated, however, in most towns between the existing border in Massachusetts and New York as well as in some additional towns in southern Vermont and northern Connecticut.

Quarantine

The quarantined area was divided into 22 districts in 1913 with an experienced inspector in charge of each district, which resulted in promptly available inspection service for the shippers at all points within the quarantined areas. It was also the duty of the inspectors to examine and clean railroad sidings and other sites from which egg clusters and larvae of the gypsy moth and winter webs and larvae of the brown-tail moth might be distributed. Shippers were advised to pile lumber and logs, and to set out quarried stone in locations where inspections could be simplified so that these products, if held over for a season, would not become infested by migration of caterpillars from surrounding infestations. This was accomplished by placing the material in open fields away from trees or brush. (Plate XXXV and XXXVa)

Early in the fall of 1914 it was discovered that stone had been shipped from a badly infested area in Billerica, Massachusetts, to an estate in Brathenahl, Ohio. This estate was the site of an isolated colony which had been found and cleaned up early in the year. The Ohio State Nursery Inspector was notified and he found several gypsy moth egg clusters on the stone, some of which were broken. About the same time several egg clusters were found on rough lumber used to hold granite in place on a freight car destined for Chicago, Illinois from Rockport, Massachusetts. As a result of these incidents the quarantine regulations were amended on Octover 25, 1914 to include the requirement that stone and quarry products must be inspected and

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certified before shipment outside the quarantined area. During the remainder of the fiscal year 15,944 shipments of stone and quarry products were inspected and 387 gypsy moth egg clusters were found and destroyed. A table is given showing by years the number of shipments inspected and the gypsy moth and brown-tail moth infestations treated before certification of shipments were made.

Fiscal Year	Shipments Inspected	Gypsy Moth Found		Brown-Tail Moth Found	
		Infested	Egg Clusters	Larvae, Pupae	Webs Larvae
1913			531	11	115 12
1914	17,076		4,476		1,435
1915	32,314	359	10,962	289	218
1916	37,444	644	10,067	1,092	517½
1917	42,596	973	11,226	341	68
1918	33,990	1,017	15,596	8,494	3
1919	29,394	966	5,932	1,010	1
1920	33,456	921	6,055	699	2
1921	39,174	1,151	10,785	768	2
1922	31,530	1,189	8,632	715	18
1923	56,799	946	10,460	192	1

Changes in the quarantine regulations were effected from year to year revising the area placed under regulation as the gypsy moth continued to spread, mostly to the north on account of wind dispersion from the most heavily infested areas, since the prevailing winds were generally from the south or southwest at the time the caterpillars were small enough to be wind-borne.

Notice of Quarantine No. 22 was made effective on July 1, 1915 and for the first time permitted shipment, under the regulations, of Christmas trees and greenery from the quarantined area. This modification was in the nature of a trial after consideration of protests by Christmas tree operators. The following year a radical change in policy in respect to the quarantine was ordered by which the territory under quarantine was divided into a "lightly infested area" and "a generally infested area". This was accomplished by Notice of Quarantine No. 25,

effective July 1, 1916, and under the new regulations shipments of quarantined plants and products were permitted movement without inspection only from the lightly infested area to the generally infested area and from point to point within each area. Interstate shipments from the generally infested area to the lightly infested area or beyond, as well as shipments from the lightly infested area to points outside required inspection and certification. These restrictions were a distinct advantage in preventing the possibility of reinfestation of lightly infested areas where clean up work had been done, a possibility which might have occurred under the original quarantine which permitted movement without inspection anywhere within the quarantined area. A requirement was also made that freight cars, and other vehicles, must be cleaned if used for transportation of quarantined products before they could be moved from the point of unloading or destination of the shipment. July 1, 1917 to 1920 the quarantine was revised to conform to the infestations found in the scouting operations so that on July 1, 1920, 25,316 square miles were under gypsy moth quarantine.

There were no umusual developments in the quarantine and inspection work during the years 1920 to 1923 except that the greatly extending area under quarantine on account of the gypsy moth necessitated a redistricting of the territory in the summer of 1922 so that it could be promptly serviced by the inspection force. Although the regular force was not increased the inspectors were able to cover the districts without undue delay to shippers by temporary transfer of qualified personnel from the scouting force for seasonal work such as nursery and Christmas tree inspection.

The value of this work may be well appreciated when it is realized how definitely and in what volume the possibility fo spread by shipment

of infested products is blocked at the source, and that the destinations of shipments included localities in nearly every State throughout the United States and many areas in Canada. (Plates XXXVI and XXXVIa)

Some Results Secured During the Period

Among the methods tried and discontinued because they did not bring productive results was inspection of trains to prevent spread of the brown--tail moth. Thinning and treatment of infested roadsides was discontinued as soon as the most dangerous areas were treated and their future care could be turned over to the towns.

Notable results on the scouting and clean up work included, in addition to the extermination of the insect in many local areas in the border towns, the eradication of isolated colonies in Geneva, New York and Cleveland, Ohio which were many miles beyond the infested towns. Spraying equipment and the methods of treating infested woodland areas were greatly improved so that increased acreages could be covered. Improvements were also made in thinning infested areas and the trees that were most susceptible to gypsy moth attack were removed so as to leave growth which was less favorable as food for the insect. This is a method that could be practiced by owners of woodland when removing trees for lumber or fuel.

Additional satisfactory methods were the introduction and distribution of parasites and natural enemies of the insect so that by the end of the period most of the species had been colonized throughout the infested territory and some of them were surviving in substantial numbers.

The establishment and enforcement of the Federal quarantine covered the gypsy moth and the brown--tail moth with reasonable provisions

for safeguarding the spread of these insects on plants and plant products and an amendment whereby stone and quarry products were included was satisfactorily enforced and prevented the establishment of the insect in many areas throughout the United States. A change in this quarantine after it had been in operation a few years provided two zones known as the generally infested area and the lightly infested area and made possible the prevention of spread of the insect on shipments to the lightly infested area in sections where intensive clean up operations were being carried on.

Arsenate of lead in powder form was purchased and used on the Federal work for the first time during the spraying season of 1919. Several distinct advantages of this form over the paste form, which had been used heretofore, were noted and its use has been since continued with very satisfactory results. It is less bulky, easier to handle and, when properly agitated, remains in suspension in the spray mixture as uniformly as the paste form. It should be understood that spray formulas giving weights of arsenate of lead which are mentioned in this report subsequent to 1919 refer to the dry, powder form.

The results of the reorganization of the Federal work in 1913 whereby the management of the different phases were centralized has been reported for the period to 1923. The system adopted has worked effectively as it made possible constructive efforts on all phases of the problem, concentration on the items that were most urgent, immediate reassignment of personnel to meet seasonal or emergency conditions and the development and improvement of methods by specialists and experienced men with the minimum amount of effort and overhead. It is readily capable of expansion whenever necessary and ~~xx~~ covers prac-

tically every line of endeavor which is practical or necessary to meet the purpose for which the project was established.

Wartime conditions, lack of experienced personnel and insufficient funds when they were most urgently needed prevented greater accomplishments but the results, including the excellent cooperative spirit with the States and local organizations as well as the public, gave the project and the Bureau high standing in the areas in which it operated.

PART IV

New Jersey Extermination Project

Early in July 1920 a report was received at the Federal gypsy moth office, Melrose Highlands, Massachusetts, that a severe infestation of the gypsy moth had been found near Somerville, New Jersey, on the estate of Mr. J. B. Duke by one of the State inspectors. Arrangements were immediately made to visit the infestation in company with Mr. Harry B. Weiss, the State Nursery Inspector, and it was found that the pest was present in extraordinary numbers in a large area of Koster blue spruce trees which had been imported from Holland in 1911. Delivery was made before the enactment of the Plant Quarantine Act by Congress. Many of the trees had been used by landscape architects for beautifying the estate and were planted soon after their arrival. The large surplus which remained was planted in nursery rows. Some were used later for replants and others had been sold from time to time to nurseries and private individuals. The estate occupied more than 1,000 acres and artificial plantings had been made of many spe-

cies of trees to conform to the planting plans. In an area near the center of the blue spruce block several acres of trees were dead or in a dying condition as a result of gypsy moth feeding. (Plates XXXVII, XXXVIIa, and XXXVIIb) Most of the caterpillars had ceased feeding and egg clusters were being deposited by the moths. They were so abundant on many of the trees that the trunks, branches and even the foliage appeared as though covered with heavy yellow felt. There were no areas of similar growth that had ever come under my observation where there had been such a heavy egg deposit or injury to species of supposedly innume trees when grown in a clear stand.

The State of New Jersey had no funds that could be allotted to carry on work in this infestation and on account of this unforeseen emergency a group fo 40 selected men were immediately sent to Somerville from New England to determine in a rough way the extent of the infestation so that an estimate could be made of the cost of the work which should be done.

By arrangement with the State Nursery Inspector the Federal work was assigned to Mr. H. L. McIntyre who had charge of the scouting and treatment work for the gypsy moth project of the Bureau. Mr. H. A. Ames was placed in charge of the local operations. Mr. C. T. Davis was detailed as his first assistant and a temporary office rented by the State was established at Somerville.

In the meantime an effort was made to secure from the estate records of all trees that had been shipped at various times and the destinations to which they had been sent. These records had been accurately kept and were gladly furnished. The data was classified and skilled men were selected to trace the shipment.

Earnest cooperation was speedily secured from Mr. Alva Agee, Secretary of Agriculture, Mr. Weiss, State Nursery Inspector, and from Dr. T. J. Headlee, who was State Entomologist and Entomologist at the State Agricultural Experiment Station.

An interview was secured with Mr. Duke, and Mr. Headlee, Mr. McIntyre and myself pointed out to him the seriousness of the situation. We indicated that the infestation was brought in unintentionally on stock which came exclusively to his property and as a result not only his own trees but those in adjoining areas were exposed to the same danger. It was also indicated that an attempt would be made to secure Federal funds to carry on the work and that there was little question but what the State would appropriate money for this purpose. He was very much interested in the findings but believed that if the work was to be done that it should be effective and thorough so that the insect would be wiped out. As a result of the interview he pledged the sum of $25,000 for work to be done exclusively on his property and desired that the bulk of this money should be expended for spraying equipment and materials and a smaller amount for labor, the expenditures to be approved by the superintendent of his estate, Mr. D. J. Smith.

At a special session of the New Jersey Legislature which was held toward the end of the year $112,000 was appropriated for work for this project. This action was timely as the small amount of Federal funds available was practically exhausted at the time this action was taken. On March 3, 1921 deficiency funds were provided by Congress to meet this unforeseen emergency.

As the result of tracing all shipments it was found that 261 had

been made to 17 States outside of New Jersey as follows: Connecticut, Delaware, District of Columbia, Florida, Illinois, Indiana, Kentucky Maryland, Minnesota, Missouri, New York, North Carolina, Ohio, Pennsylvania, Virginia and Wisconsin. In addition to these 518 shipments had been sent to 17 different towns in New Jresey. To make the matter more serious some of these trees had been bought by nurseries and landscape architects and had been reshipped to dher points so that an enormous amount of time and labor was necessary in order to trace this stock and determine whether infestation had been transmitted on it. The entomologists of the different States were notified and in many cases assisted in following up the shipments. As a result of this work small infestations were found at Loretto, Pennsylvania; Garrison, Roslyn and Kew Gardens, New York; Deal Beach, Wyckoff, South Orange, Scotch Plains, Paterson, Madison, Glen Rock and Elizabeth, New Jersey and somewhat later an infestation was found at Mendham which may have come from some other source. All of these infestations were treated before the larvae hatched in the spring.

As the result of the finding of the infestation in New Jersey a conference was held of New Jersey, New York and Bureau officials and after a consideration of all the available information that could be readily gathered it was decided that the work should be continued on the following basis: that the infested area should be thoroughly scouted and clean up measures applied, that the extent of the infestation should be determined and that an attempt be made, in view of the fact that this was an isolated infestation and was located where it could become a serious menace to surrounding uninfested States,

to exterminate the pest and that the cost should be shared.

The proposal for exterminating this infestation was based on the success that had heretofore been attained by the Federal gypsy moth force and State gypsy moth office in exterminating the pest over substantial acreages when adequate funds and trained man powere were continuously available even though conditions confronting the work were difficult. It was also considered that in the end extermination would be the cheapest and most effective method that could be employed.

The matter of quarantine was fully discussed and it was finally decided inasmuch as the State of New Jersey had an effective State inspection force and they were in touch with the nurseries that were located in the area and that there was a possibility that some might be found infested when a more complete examination was made, that a State rather than a Federal quarantine was advisable to cover this isolated area and that its enforcement be placed in the hands of the Federal authorities cooperating with the State. Previously it had been determined that the gypsy moth work in the State should be supervised by the Federal gypsy moth office in cooperation with the State Department of Agriculture and that the men would be selected or furnished by the Federal office, the idea being to man the force with competent experienced men so that the maximum amount of effective work could be done in reducing and stamping out the pest before it had a chance to spread materially.

The New Jersey quarantine was made effective October 4, 1920 and provided for the regulation of movement of plants and plant products, stone and quarry products originating in the infested cities or townships which were specified in the quarantine regulations. Materials

of these types should not move until they were inspected and certified by an authorized inspector and employees of the Bureau of Entomology were deputized by the State to inspect and certify such products. It further provided that in view of the fact than an attempt was being made to exterminate the insect such materials should not be moved to points within the quarantined area without inspection. This was designed to prevent the spread of infestation to parts of the area which had been cleaned up from other points where the work had not been fully completed. Material to be moved to points within and without the infested area was required to be assembled and placed so that it could be readily examined without loss of time by the inspector. The requirements of this quarantine conform closely to the Federal quarantine in the New England States issued by the Federal Horticultural Board on account of this pest but it will be noted that it was unusually stringent in that it prevented the movement, unless inspected, of plant products within the infested area. From time to time as new infestations were found or areas were cleared up the quarantine was amended in order that uniform protection could be furnished the public from spread of infestation. The administration of this quarantine was very simple and there were few complaints concerning its enforcement. The fact that the extermination work accomplished justified changing the area from year to year encouraged unusual care by shippers that no infested material come within the limits of their townships.

The expenditure of funds was made by the State and by the Federal office of allotments from the State and Federal appropriations. The records were kept separately and in this way any confusion as to the amounts expended by each agency was eliminated. A separate account was also kept for the expenditure of the funds contributed by Mr. Duke,

all of these being approved and paid by his superintendent after the work had been approved by him.

The methods used on this work were similar to those applied in the New England territory, consisting of intensive scouting, treating with creosote of egg clusters when found, elimination of defective trees and debris in infested locations in woodland areas supplemented by banding with tanglefoot or burlap and spraying during the caterpillar season.

Trucks for transportation of men were furnished principally by the Federal Government and tools, insecticides and other equipment were purchases both on State and Government order. The State bought 9 high power truck sprayers, two were procured by the Duke Estate and in addition to this number 10 were furnished by the Bureau. They were fully equipped with hose and other accessories. All were used in 1921 but as conditions developed later where less spraying was required the Federal sprayers were gradually withdrawn. Seventy--five tons of arsenate of lead were used during the first spraying season.

The area where this colony originated and a considerable portion of the territory south of it was rather rolling country and not very heavily wooded. The northern part of the area including the Watchung Mountains composed of several different ridges was rather heavily wooded as was the case with the ridges near the Delaware River. The southeastern section included rather dense growth of pitch pine intermingled with oak, the latter predominating toward the west. Some of the territory closely resembled the Cape Cod region in Massachusetts, Long Island, New York and sections of eastern Pennsylvania. There was an abundance of tree growth which was suitable as food for the insect throughout the entire area. The infestation was found at an op-

portune time because if it had had further chance of spreading the difficulty of eradication would have been greatly improved.

As soon as a sufficient group of men could be assembled the egg clusters in the infested block of blue spruce were treated and in the central part of that area where the infestation was most dense the dead and dying trees were cut, piled and burned. Early in the spring this cutover area was plowed and remained fallow for several years. Additional treatment of egg clusters was continued on the Duke Estate and in the surrounding territory until hatching of caterpillars began in the spring. During the scouting work over surrounding territory egg clusters were treated as soon as they were found.

All the smalliisolated infestations in New Jersey that had resulted from the shipment of nursery trees as well as those found in other States were thoroughly treated and where necessary spraying was done. Intensive scouting work was immediately resumed at the close of the spraying season and additional infestations were found outside the 100 square mile area which had originally been found infested.

During the first part of the work numerous attempts were made chiefly by incompetent persons to secure employment through various pressure measures. Employment was denied and this stand met with full support of all cooperating agencies.

At the end of the year 1921 (Plate XXXVIII) it was determined that the area of scattered infestation extended over more than 400 square miles. This was computed on the basis of drawing a line around the outside points of infestation without regard to quarantine or township lines. Of necessity quarantine had to be established on the basis of township lines for the purpose of certifying material for shipment. This large area did not include small isolated infestations

which were found and treated during the course of the scouting work.

In 1922 and 1923 intensive work was done in the infested areas previously discovered. In some of the colonies no infestation was found but in others the need of additional work was necessary. No infestation was located in the outlying areas where nursery stock had been previously distributed but some new colonies were found in the area immediately outside the 400 square mile block. In the territory centering around the Duke Estate it was necessary to carry on much additional scouting and treatment work. No defoliation occurred in the State after 1921.

As the result of the enactment of a law in the State of New York providing for gypsy moth work under direction of the Department of Conservation, Mr. McIntyre withdrew from the Bureau to take charge of the work in that State. His appointment was effective April 16, 1923 and Mr. H. L. Blaisdell, who had had long experience on Federal gypsy moth field work in many sections of the infested territory, was appointed to take charge of the scouting and extermination branch of the work including the New Jersey project. There was no material change in the personnel operating the New Jersey project although the territory was subdivided into districts to make possible more complete administration of the work. In September 1923 the Somerville office of the project was moved to Bound Brook, New Jersey, and later in the season a storehouse which had been recently constructed and was well adapted for storage of supplies, also automobiles, sprayers, tools and equipment and for repair work was also rented near the office at Bound Brook. (Plates XXXIX and XXXIXa)

In the years that followed a plan of operation was used which provided for rescouting of the sites and surroundings of all infested points in the 400 square mile area and applying exterminative treatment. In addition to this it was necessary in order to make sure that no outlying infestations existed in territory beyond this area to gradually extend intensive scouting work into adjoining territory.

Past experience indicated that when rainy weather was prevalent during the spraying season a considerable portion of the spray material washed from the foliage so it was necessary to respray the trees and in some cases even two or more additional sprayings were necessary. This made spraying very expensive and was particularly important on the New Jersey work because during the first few years that the work was carried on there a large amount of respraying had to be done which greatly increased the cost of operations and diminished the area that could be treated in a single season and, as a rule, was not as effective as one treatment which was tightly bound to the foliage. After a long series of experiments which were carried on for several years at Melrose Highlands laboratory, and which are mentioned in more detail in the following chapter of this report, a number of materials, notably light pressed fish oil and raw linseed oil, gave promising results on an experimental basis. In 1924 field demonstrations were conducted on acre plots at Watchung Ridge and Dukes Park, New Jersey, during a very rainy spraying season with excellent adhesion of the spray material when either fish oil or linseed oil was used in the mixture. Fish oil can be purchased at a lower price and is therefore used in preference to linseed oil. Spraying during the following years in the New Jersey area was more effective after this adhesive was used and it has been in general use ever since in many States where arsenate of lead sprays are applied.

From 1924 to 1927 some intensive scouting and clean up work was done within the 400 square mile area (Plate XXXVIII) and similar scouting was also done in the outside zone so as to be assured that no scattered infestations were present. This resulted in the discovery of a limited number of infested localities most of which were in townships immediately surrounding and near the inner part of the outside band. All infested places were thoroughly treated. The work was then pushed into the outer part of the 400 mile area at the same time checking up on the central section. This made possible a reduction of the cost of the work and this method continued by gradually eliminating the areas and sites which had been previously infested until May 1929 when the last infestation was found.

This did not remove the necessity of inspection of territory in and surrounding the latest cleaned up colonies or in sections so located that the possibility of missing infestations seemed to be the greatest.

Beginning in 1928, as an adjunct to the scouting work and as a precautionary measure, assembling cages which contained an extract used to attract male moths were used annually in the New Jersey area. Some were placed in the larger band around the periphery of the 400 square mile area; others near some of the colonies that had been cleaned up and in sections within the central area where there was a possibility that some stages of the moth might have been overlooked. From 1928 to 1931, 3,393 cages were placed in 29 towns but no males were caught. During the years 1930 and 1931 intensive scouting xx revealed no infestation so that on May 4, 1932 the quarantine was lifted and the Federal work was discontinued and the Federal force that remained was transferred to the New England area.

The total expenditures of New Jersey were $1,086,511.13 and of the Federal Government 1,262,257.87. (Plate XL)

The highest number of men employed on the project was 473. After 1926 the number decreased annually until the project was finished.

The number of colonies was reduced from 833 with over 3,000,000 egg clusters in 1920 to no egg clusters and colonies in 1930.

These figures do not include the destruction of other forms of the moth which were killed each year by spraying, burning infested material or destroyed under tree bands.

At the time the Federal work was withdrawn in 1932 the State of New Jersey took most unusual action. Having made large expenditures on this project they adopted the policy of protecting that investment by securing a small appropriation from the State Legislature so as to retain a small force of experts. Arrangements were made with the Bureau to transfer Mr. Ames, who had charge of the Federal work during the entire project, to continue work in the State and he was made a collaborator of the Plant Quarantine and Control Administration in order that cooperation could be maintained with the Federal office. Three of his well trained and competent assistants were also transferred and this small force has since that time carried on gypsy moth work for the State. This has consisted of patrol and inspection work in various areas where there was possibility of introduction of the pest due to extensive shipping of materials that might inadvertently bring it into the State, to examine material for planting or redistribution and to continue the assembling cage work in areas which seemed to be the most dangerous. It was the most unusual and so far as I know unprecedented action that has ever been taken upon large

insect control or extermination projects and showed the farseeing interest of the State and confidence in the work that had been done.

In the spring of 1933 the New Jersey force found egg clusters in woodland in the town of Mendham and a male moth was taken at a cage during the summer but no egg clusters were found near the cage. Intensive scouting and clean up work was carried on during the fall of 1933 and the winter of 1934 but during the following summer male moths were taken. No egg clusters were found in the area that had been cleaned and treated but in another area where moths were taken in the summer of 1934 a few egg clusters were found. A male moth was attracted to a cage in the town of paraquarry adjoining the Delaware River. Careful inspection of the territory as well as adjoining towns across the river in Pennsylvania during that and succeeding years failed to reveal any infestation. A similar condition developed in 1935 in Mendham and in 1939 in the residential section of the borough of Englewood. No infestations have been found as a result of intensive scouting around these areas. From 1933 to 1935 the State force was supplemented by additional trained scouts and equipment for treatment from the Federal office and during the years 1936 to 1938 by men procured from WPA allotments and intensive and thorough examinations were carried on over large areas supplemented by the use of cages but no trace of the insect was discovered. Checking work by the State force has been done annually since then and cages have been used each year with negative results.

From 1933 to 1942 State funds have been expended amounting to $111,264.86. Federal funds of $15,484.28 and WPA allotments in 1936 to 1938 of $114,619.22.

It had been amply demonstrated many times that the gypsy moth could be exterminated under the most difficult conditions on limited acreage but a project involving the extermination of the pest where it became necessary to examine intensively and absolutely eradicate it in an area covering at least one third of a State as large as New Jersey was considered impossible by nearly everybody, including some of those who were friendly to the gypsy moth work.

I was told personally by a former Assistant Secretary of the United States Department of Agriculture that if this could be done there would be no future difficulty in securing all the funds that might be needed for Federal gypsy moth work.

The success of the New Jersey project, the largest of its type that has ever been accomplished, was due to the full support of the Bureau of Entomology and the perfect cooperation of the New Jersey Department of Agriculture and all of the officials concerned with the work, the necessary funds to carry through the work aggressively and above all the efficiency and devotion of the supervisory and field men who toiled unceasingly to produce the maximum of effective results.

The New Jersey project was operated concurrently with the work covered by the 1923-1933 report which follows.

PART V

Gypsy Moth and Brown-Tail Moth Work 1923-1933

The continued westward spread of the gypsy moth in New England which in 1922 had reached the New York State line caused apprehension and alarm, to officials in New York in particular, that the funds at the disposal of the Federal gypsy moth organization were inadequate in view of the very extensive area infested to prevent further spread and escape of the insect into more western States. The apprehension reached tangible form when in the fall of 1922 an infestation was found in Petersburg, New York, a town adjoining the Massachusetts and Vermont State lines.

A conference was called to discuss the problem and the means for holding the gypsy moth in check. It was held in Albany, New York, on November 16, 1922 at the invitation of Mr. Berne A. Pyrke, New York State Commissioner of Farms and Markets, and the situation was thoroughly discussed and resolutions were drawn up as a basis upon which a feasible and practicable policy could be established. Among those present at the conference were representatives of the United States Department of Agriculture, of the several New England States, New Jersey, New York, and the Dominion of Canada, all of whom were interested officially in the gypsy moth problem. After considerable discussion the following resolutions were adopted:

"WHEREAS, The gipsy moth is one of the most destructive insect pests affecting forest, shade, fruit, and park trees; and enormous damage has been caused by this insect in New England; and upwards of twenty millions of dollars have been expended by these states and the

Federal Government in their efforts at suppression and control, and,

"WHEREAS, The spread of this insect constitutes a serious menace to the forest, shade, fruit, and park trees of New York State and the territory south and west thereof, and,

"WHEREAS, It has been demonstrated that in local infestations, as in the case of New Jersey, complete eradication may be possible, and that over wide areas general control measures to reduce damage and injury are practicable, and,

"WHEREAS, Owing to topographic features, distribution of different kinds of trees and feeding habits of the insect, it is believed that a control zone should be established from Long Island Sound, in a general northerly course, east of the Hudson River, through New York or New England, or both, for the purpose of premanently preventing the spread of this insect, therefore, be it

"RESOLVED, That it is the sense of this conference composed of foresters, agriculturists, entomologists and administrative officials, from the New England states, New York and New Jersey and representatives of the United States Department of Agriculture and the Dominion of Canada, held at Albany, New York, November 16, 1922.

"That, sufficient appropriation should be obtained by the states interested, and the Federal Government for the purpose of continuing and strengthening present control methods in the infested areas, to eradicate the New Jersey infestation, to do necessary scouting for the discovery and destruction of border infestations, to determine the location of the most practicable place for a control zone, to take necessary steps to make control therein effective, and for the destruction of all infestations in and west of said zone."

Although the New Jersey infestation complicated the situation, in that Federal funds for use in that State were necessarily drawn from funds which otherwise could have been used in New England, it was considered, and the work was carried out, as a separate project. The Albany conference was concerned chiefly with prevention of further natural spread of the gypsy moth from New England and the proper solution seemed to rest upon a concentration of efforts within an area at the western limits of the New England infestation cooperatively expended by the States concerned and the Federal Government. This plan, the sense of the Albany resolutions, was adopted and immediate steps were taken to put it into effect.

The detailed report of the conference and its discussions was published in December 1922 by the Department of Farms and Markets of the State of New York in its Agricultural Bulletin 148, "The Gipsy Moth - An Imminent Menace to the Forest and Shade Trees of the State of New York."

The New York State legislature in the early spring of 1923 passed an act giving authority to the Department of Conservation to administer gypsy moth extermination work and providing $150,000 for this purpose. Mr. H. L. McIntyre, who had been in charge of the Federal scouting and extermination work since 1919, was offered the position of supervisor of the New York work which he accepted and to which he was appointed on April 16, 1923. Dr. E. P. Felt, then New York State Entomologist and strong protagonist of the newly adopted plan, was appointed to be Chief Entomologist.

Later Mr. Saul Phillips, who for many years had carried on extensive gypsy moth work in the State of Massachusetts and who had extended

experience on corn borer control work, was transferred to the Federal gypsy moth project and assigned to work in cooperation with the New York Conservation Department. With the resignation of Mr. McIntyre from the Federal service one of his assistants, Mr. H. L. Blaisdell, was promoted to direct the Federal scouting work on April 16, 1923. He took charge of the supervision of the extermination project in New Jersey and of scouting and treatment work in the barrier zone as well as exterminative work in new outlying colonies.

Further conferences were held with officials in the New England States and New York relative to setting up tentative bounds for the establishment of the zone and after detailed study of the situation, taking into consideration the topography of the territory and the type of woodland and open country involved it was decided to select the following area, subject to changes relative to the infestation which might later be found; the northern limit was the Canadian border from the western bank of Lake Champlain to a point near the crest of the Green Mountains, thence southward to the Massachusetts line following the Berkshire Hills in Massachusetts and the Litchfield Hills in Connecticut to Long Island Sound, thence west along the sound beyond Bridgeport north to the southeastern corner of Putnam County, New York following the county line to the Hudson River, thence following the Hudson River and northward along the west bank of Lake Champlain to the Canadian border. Aside from the distince height of land on the east, the western border was bounded roughly by the Adirondacks and Catskill Mountain ranges in New York. This area was modified slightly as infestations were found and exterminated. (Plate XLI)

It was decided that the greatest degree of cooperation should be made effective in all the States concerned if the project was to be

successful, and this state of affairs was achieved and has continued uninterruptedly throughout the years which followed. It was necessary for the Federal Government of discontinue work east of the zone boundary except for the purpose of determining areas on which quarantine lines should be based and for the New England States to assume additional responsibility for the condition of the territory and back up the work which was being done east of the barrier zone line.

In view of the fact that there were large areas in the proposed zone which had never been inspected, particularly in the New York portion, and because of the willingness of the New York officials to do their utmost to keep the zone clear of infestation in New York State, it was agreed the responsibility for the work in that State, except for emergencies which might at any time unexpectedly arise, would be assumed by the Conservation Department and the territory in the zone east of the New York State line in some portions of which the insect was already established would be handled by the Federal office. Surveys were begun as rapidly as possible. A new organization was created by Mr. McIntyre in New York and the Federal force was realigned to make surveys in order to determine whether infestations were present so that the program or the barrier zone lines themselves could be adjusted accordingly. Most of the scouting and control work during the period 1923-1933 was carried on in the zone, and gradually the work assumed such shape as to indicate that the action taken at the Albany Conference was thoroughly practicable.

On December 11, 1926, Mr. Rogers retired from the service and his position in charge of the quarantine section was filled by assignment of Dr. J. N. Summers, who had been engaged for several years

on parasite work at the laboratory and who had demonstrated an unusual ability for administration. The following year on October 16, 1927 Dr. Howard relinquished his duties as Chief of the Bureau and was succeeded by Dr. C. L. Marlatt who, upon reorganization of the activities within the Department of Agriculture, also became the first chief of the new Plant Quarantine and Control Administration. Mr. S. A. Rohwer was appointed Assistant Chief and Mr. Bernard Connor Business Manager of this Administration. This reorganization took effect on July 1, 1928 bringing within the new Administration all plant quarantine, regulatory and control activities of the Department concerning insects and plant diseases including the gypsy moth and the brown--tail moth. The research work carried on by the laboratory remained in the Bureau of Entomology and was assigned to the Division of Forest Insect Investigations, and $95,620 was transferred from the gypsy moth funds for that work. The next important change in the Administration took place on December 1, 1929 when Dr. Marlatt withdrew as Chief of the Administration to give his full time to the Bureau of Entomology. Mr. Lee A. Strong was appointed to fill the vacancy. Mr. Rohwer remained as Assistant Chief and Mr. Connor continued as Business Manager. In 1931 Mr. Rohwer became Assistant Chief of the Bureau of Entomology and was succeeded by Mr. Avery S. Hoyt as Assistant Chief of the Administration. On July 1, 1932 the title of the Administration was changed to the Bureau of Plant Quarantine.

After the establishment of the barrier zone a building was leased at West Pittsfield, Massachusetts, to serve as a storehouse for supplies and equipment including motor vehicles and sprayers as well as a shop for making necessary repairs on all types of equipment used on the work.

Property of this type stored elsewhere was moved to Pittsfield, Regional headquarters remained in Melrose Highlands, Massachusetts, until the summer of 1931 when several buildings were leased from the Greenfield Tap and Die Corporation, Greenfield, Massachusetts, and all office and storage facilities were consolidated there except a small sub-office in Boston which was continued to handle inspection work required in that city. (Plates LXVI to LXVIIIa)

Field and Laboratory Research

The decision was reached in the latter part of 1921 to resume parasite studies in foreign countries which had been interrupted by the First World War. It had become increasingly clear that while the parasites already established were of great value their importance as means for controlling the gypsy moth did not satisfactorily approach the value evidently reached in the native homes of the insect. Preliminary studies were undertaken by Mr. Crossman in Europe and by Dr. Summers in Japan in 1922, and the results indicated that a long range attempt should be made to discover the factors governing successful parasitism and to apply all useful information secured to the problem in the United States.

In 1923 Dr. Summers returned to Japan, and Mr. Crossman in company with Mr. R. T. Webber explored points of likely infestation in France, Spain, Italy, Germany, Austria, Hungary, Poland and Rumania. The following years Messrs. Crossman, Webber and S. M. Dohanian were in Europe and investigated conditions in many localities which were promising sources of parasitized material. Several temporary laboratories were opened largely as convenient centers for insectaries in

which to gather material for study and shipment to the United States. In 1925 Mr. Dohanian returned to Spain and Portugal, and Messrs. Weber and P. B. Dowden journeyed to central and southeastern Europe where temporary laboratories were established in Czechoslovakia and in southern Hungary. Mr. Webber again went abroad early in 1926 and was later joined by Messrs. C. F. W. Muesebeck and R. C. Brown who remained in Europe to carry on detailed biological studies at a laboratory in Budapest in 1927. (Plate XLII)

Many innovations were devised by these men for improving the methods of shipping parasites as the result of their studies and explorations. Innumerable difficulties were overcome and the technique of collecting, rearing and preparing the different species of parasites for shipment was greatly refined. The behavior studies were extremely valuable both from the practical and the scientific viewpoint. The United States Department of Agriculture Technical Bulletin No. 86, published in August 1929, "Imported Insect Enemies of the Gipsy Moth and the B rown-tail Moth", by A. F. Burgess and S. S. Crossman, is a detailed account of the parasite work accomplished by the workers of the Melrose laboratory up to the time the research work was separated from the control work in 1928, in Europe, Japan and in the United States.

The gypsy moth became a dangerous menace to oak trees in parts of Spain and North Africa in 1926, and large numbers of Schedius kuvanae, How., a species which was originally introduced by the gypsy moth laboratory from Japan, were sent from America to help solve the problem. This species was new to science and was described by Dr. L. O. Howard.

Parasite studies at the Melrose Highland laboratory, which are reported in Technical Bulletin No. 86, dealt with many species including the successfully established tachinid Compsilura concinnata, an important parasite of both the gypsy and the brown--tail moths, first introduced into Massachusetts from Europe in 1906. Over a period of eight years from 1915 to 1922 careful observations were made of this insect to discover its effect on native hosts. Many thousands of native insects were collected for these studies and the results were published in February 1926 in United States Department of Agriculture Bulletin No. 1363, "Host Relations of Compsilura Concinnata", by R. T. Webber and J. C. Schaffner, Jr., of the laboratory staff.

During this period the laboratory force was engaged in many other lines of research, all designed to discover or improve field control methods for greater efficiency in field operations. One of the most outstanding achievements was the result of experiments with many substances to find an effective adhesive for arsenate of lead spray. These experiments were carried on beginning in 1921 in a small way at the laboratory and then on a large scale in 1924 under field conditions in New Jersey and in Massachusetts, with further tests in 1926 and 1928. Raw linseed oil and light pressed fish oil were found to be the most fully effective, with fish oil having the advantage of lower cost which has recommended its use in preference to linseed oil on large scale spraying operations. It was found that the spray mixture containing fish oil not only adhered to the foliage and remained toxic over a long period which eliminates any necessity for expensive respraying, but that the foliage could be effectively covered when only half-grown, which

lengthens the spraying season by several days. It was found, also, that with the addition of fish oil the amount of arsenate of lead powder in the mixture could be reduced to 5 pounds per 100 gallons of water from the usual dosage of 6½ pounds, with equal effectiveness in gypsy moth extermination and control work at an obvious economy in operations. The quantity of fish oil used depends on the amount of arsenate of lead, the recommended proportion for best results being four ounces by weight of fish oil to each pound of arsenate of lead, the quantity of water in the spray tank having no bearing on quantity of fish oil used. The details of the experiments and information secured, with complete recommendations for use by the public, were published first in 1926 by Mr. C. E. Hood, who was in direct charge of the experiments, in United States Department of Agriculture Bulletin No. 1439, "Fish Oil, An Efficient Adhesive in Arsenate-of-Lead Sprays", and later in 1929 as a revision by the same author in United States Department of Agriculture Technical Bulletin No. 111, "Fish Oil As An Adhesive in Lead-Arsenate Sprays".

Observation Points and Disease

The observation points which were established in 1912 were continued from 1923 to 1928 on a reduced scale and were utilized to check on the rate of parasitism, egg deposition, the amount of defoliation, tree mortality, and the degree of winter killing of eggs from year to year. The brown-tail fungous disease was more or less prevalent from time to time and caused a very high mortality of this insect in 1923. There were no special experiments conducted in respect to diseases but as part of the observation point work considerable interest was maintained in the trend as it developed each year.

Wind Dispersion

Wind dispersion experiments conducted over a period of years had shown definitely that a large proportion of the gypsy moth spread was caused by carriage of small caterpillars from heavily infested areas by the wind and was a hazardous factor in the problem to prevent further spread of the insect. Attempts were made beginning in 1923 to determine, if possible, what these hazards presented in preventing spread into the barrier zone and beyond. Investigations were undertaken at first under the direction of Dr. E. P. Felt who gathered a condiserable amount of data from United States Weather Bureau stations and from temporary weather stations set up at several strategic points throughout the Berkshire range and the Hudson and Champlain Valleys. The data consisted of wind directions and velocities and temperatures which were favorable to spread of small gypsy moth caterpillars. As a supplement to weather station records Dr. Felt released about 7,000 inflated toy balloons in 1923 and over 8,300 balloons in 1924 during the period from about the middle of May to the end of June to determine, if possible, the distances they would be borne by the wind under different wind velocity and varying temperatures conditions. Only about six per cent of the balloons were recovered so that the information was not entirely significant, and it was indisputable at time that the drift of the balloons did not always coincide with the wind direction at the point of liberation, doubtless because cross currents at high altitude varied from the direction shown by weather instruments on the ground.

The experiment with the balloons was not continued after 1924 but records were collected from the temporary self-recording weather stations and from the permanent weather bureau stations for several years. These records were carefully studied and while the information corroborated some of the data previously secured during early studies on wind dispersion they were not sufficiently inclusive to warrant a forecast on spread or conclusions that new infestations would be found in any definite direction beyond previously known infestations. These wind dispersion studies were undertaken in cooperation between the New York State Conservation Department and the Greenfield office.

Defoliation

As mentioned above standards for measuring the abundance and the amount of danage caused by the gypsy moth and data relative to the increase of the species was based largely upon information gathered at the observation points. The number of egg clusters laid, the amount of winter killing and egg parasitism have been usually the only indication of the increase or decrease which might be expected in caterpillar population the following year. These did not, however, give positive indications of the actual damage caused. The damage to or death of trees is the direct result of defoliation and after study of observation point records it appeared that defoliation could be measured in such a manner that damage would be better understood. (Plate XLIII) Starting in 1924 the entire area infested by the gypsy moth was examined by employees of the Bureau and of several States which cooperated in this sruvey. Insofar as possible the same men conducted these surveys in the same region each year so that the results of their observations have been constantly comparable. On ac-

count of the large area involved the data represents the minimum acreages as many large areas could not be observed on account of the topography of the country.

Silviculture

The intensive silvicultural investigations which were interrupted in 1917 by the resignation of Mr. Clement were continued less intensively by Mr. Munro who also made a study of the utilization of products cut during silvicultural operations with special emphasis on the cordwood market. Data on defoliation, tree mortality and abundance of the gypsy moth were gathered by men who were doing similar work at the observation points and during the last part of the period this work was somewhat reduced in volume and the data was obtained by Mr. I. T. Guild.

The Brown-Tail Moth

The brown-tail moth work which for many years had been done in connection with the work performed for control of the gypsy moth was of concern to the Federal organization because it affected the amount of territory infested. A few men were detailed in 1923 to scout in Maine and New Hampshire to determine the amount of spread so that quarantine lines might be more accurately defined. A very slight increase to the north was found in these States. Reports were received periodically from States interested indicating that defoliation existed in the Merrimac River Valley, along the seacoast of New Hampshire and in southwestern Maine. The degree of defoliation and the abundance of the insect fluctuated from year to year. Collections were made each year to determine the rate of parasitism which it was found depended

to no small extent upon weather conditions. In 1927 and 1928 parasites apparently were so abundant in some sections that serious injury to trees was not particularly noticeable. Continuous field control work in Massachusetts and some other areas reduced the insect substantially. From 1929 to 1933 there was noted a steady increase in the number of brown-tail webs so that the brown-tail moth became a decided nuisance particularly in the areas of Maine and New Hampshire frequented by vacationists. This situation resulted in extensive work by State forces in 1931 when more than 2,000,000 winter webs were cut and burned in Maine and New Hampshire. By 1933 due to migration the brown-tail moth was again found in towns along the Connecticut River in Vermont.

The Satin Moth

On June 22, 1920 an insect was discovered feeding on Carolina poplars in the Middlesex Fells Reservation at the Malden-Medford, Massachusetts city lines by an employee of the Metropolitan Park System. It was determined that this insect was the satin moth which is widely distributed throughout Europe and Asia and sometimes of economic importance through not usually considered a particularly serious pest as its food plants are confined to different species of willow and poplar. Not long after this discovery infestation of the same insect was reported in British Columbia and two years later in the State of Washington. The history of its introduction in Massachusetts is not too clear but it probably had been present for several years prior to 1920. The area was scouted at the request of the Bureau with the cooperative assistance of State officials concerned as soon as the insect was identified and it was found to be present over an area of 642 square miles including 60 towns in Massachusetts and 4 in New Hampshire. Most of the work against this insect was undertaken at once

by the States and property owners and some scouting was performed to define the extent of its spread until 1924. State, local officials and owners continued work where the insect was most abundant but some spread continued until in 1931 infestations were reported in most towns in southern New England, Vermont towns adjoining the Connecticut River to Newbury, Vermont and south of that town in a northeasterly direction across New Hampshire and to Forest City, Maine at the New Brunswick international line.

Acting on the premise that the satin moth had been introduced into this country without the benefit of parasites which doubtless have been responsible for its control in various countries, the Federal Horticultural Board promulgated regulations under Quarantine No. 53 on January 1, 1922 which prohibited the movement of all species and varieties of poplar and willow and any parts thereof capable of propagation. The area under quarantine was extended year by year until December 1, 1932. It was also reported in scattered localities over one half of the State of Washington and in Vancouver, British Columbia.

Investigations wer made by the gypsy moth laboratory at Melrose Highlands to discover means for controlling the satin moth. All control work was performed by individuals or by the local authorities and unfortunately this was sporadic and no doubt contributed to the rapid increase during the period 1924-1928. As a stimulus to better control and better understanding of the nature of the insect there was published in February 1927, United States Department of Agriculture Bulletin No. 1469, "The Satin Moth, A Recently Introduced Pest", by A. F. Burgess and S. S. Crossman. After several years' study of the habits of the insect recommendations for its control were published

in October 1931 in United States Department of Agriculture Circular No. 189, "Control of the Satin Moth by Spraying in Alternate Years", by C. W. Collins and C. E. Hood.

Scouting and Treatment

Scouting was performed in the winter of 1922-1923 along the western border of the infested area and in northern New Hampshire under very difficult weather conditions and with a great lack of experienced men. A large amount of time in the early part of the season was consumed in recruiting and training workers, unfortunately in competition with high wages and good business conditions existing on private work. In spite of these difficulties the work, including spraying, in New England and at the newly discovered infestation in Petersburg, New York, was completed in the spring except in the northern part of Vermont. At this time plans were being changed so as to establish the barrier zone.

It was apparent at the beginning of the fiscal year 1924 that sufficient funds were not available for a complete scouting and cleaning of the entire territory bordering the infested area of New England and to examine, in addition, the 20 mile wide strip of towns east of New York in the barrier zone. As a result the border work was abandoned and all efforts were concentrated on the barrier zone work in New England where roadside and open scouting was conducted in practically all the towns in the area as well as in a few towns on the west bank of Lake Champlain, New York. The New York State Conservation Department planned to do similar work, and were able to cover a large part of the area, in the territory between the Hudson River and the New England States. Colonies were found and treated in 4 new towns in Connecticut

and in 10 towns in Vermont including an infestation at Alburgh where over 6,000 egg clusters were discovered. In New York new colonies were found in 9 towns east of the Hudson River, practically all of which were of small size. Federal scouts also conducted treatment work on Long Island at three colonies in the vicinity of Greenport. Additional funds were made available in April 1924 and it was possible to thoroughly treat and spray practically every infestation found,

In the fiscal year 1925 increased funds were appropriated and roadside and open scouting was conducted by Federal employees in every town in the barrier zone in New England as well as in several towns on the west bank of Lake Champlain, in Washington County and in two towns in Putnam County, New York. State crews completed the coverage of barrier zone towns in New York with similar scouting. No new infestations were found except in three towns in Vermont and two towns in southwestern Massachusetts where previous scouting had been undertaken. Most of the colonies were small and greatly reduced in size from those found the previous year. Small colonies were discovered in Chesterfield and Moriah, New York, west of Lake Champlain, and prompt exterminative measures were applied. The intensive work at the Alburg, Vermont colony was so effective that only three egg clusters were found when the colony was rescouted this year. Considering the area as a whole conditions were promising that, with continued effort, the barrier zone program would prove to be feasible as a means for preventing further spread of the gypsy moth.

In the fall of 1924 assistants of the Dominion Entomologist found several egg clusters in the town of Henrysburg, La Colle township, Quebec, about three miles north of the United States-Canada boundary

line. Nearly 3,000 egg clusters were found and creosoted during the winter and the colony site was thoroughly sprayed the following summer. Federal assistance was given in 1924 by training men for scouting at infested areas in the United States and in both 1925 and 1926jby loan of a sprayer and an operator for treatment work. This colony was exterminated by 1927 although Canadian officials continued to scout the area for several years thereafter. This infestation was probably brought in unintentionally by relatives of the family who lived in the infested area in Massachusetts as they frequently visited them.

In 1926 the New York State force confined its work in the barrier zone to the area south of Washington County, New York and scouted areas in the Mohawk Valley, in the Catskills, in Westchester County and on Long Island. The Federal force scouted most of the barrier zone area in New England and a strip of towns north of Washington County in New York and treated all infestations found. It was also planned and the plans were consummated in 1926-1927 to scout a few of the towns east of the zone in New England to determine if really bad infestations might exist which were of danger to towns free of infestation within the barrier zone and to which spread by the wind was a dangerous possibility. (Plate XLI)

In view of the need of more intensive scouting work in barrier zone woodland and the imminent threat of reinfestation of the zone because of substantial increase of infestation in contiguous territory directly to the east, annual recommendations were made for increased funds for work in these areas between 1924 and 1930 but in every case the amounts were materially reduced or no funds whatever were provided.

Isolated infestations were found by New York scouts at Kingston, New York which is on the west bank of the Hudson River and at Brooklyn, Patchogue and Montauk, on Long Island. Federal scouts found an isolated infestation at Greenwich, Connecticut. Intensive work was immediately undertaken to eradicate these colonies at once. Encouraging results led to plans for carrying on intensive scouting on a tree to tree basis where previous barrier zone infestations had existed and to curtail the work where no infestations had been found for two years. In that part of the zone where the New York force was employed no new infestations were found in the scouting season of 1926-1927 and the Federal crews, working in Putnam and Dutchess Counties of New York as well as in New England, although deterred somewhat during the winter by unfavorable weather, were able to report satisfactory progress with a large amount of close scouting work accomplished. There was an unfortunate interruption in the work in 1927 when disastrous floods swept through the river valleys in Vermont and Massachusetts in November. The floods which caused loss of live and tremendous property damage also washed out many roads, bridges and railroads in the area where Federal crews were engaged and since this was at a season of the year when it is usually impossible to do road work the crews were greatly delayed in reaching the sections where field operations were planned. Many of the crews as a result were transferred to sections east of the barrier zone in northern Vermont for a short period. It was possible to resume work in the flooded area later in the winter and at three dangerous infestations which were found the previous season adjacent to the zone in the towns of Pittsford, Rutland and Ira, Vermont, which were intensively treated with the result that

no infestations were found the following year at these sites. Federal scouting was done, also, on a tree by tree basis on the Lake Champlain islands. This year conditions were generally better over the entire zone except for an infestation at Wallingford, Connecticut where a large woodland colony was found, and in the territory in the southern part of Berkshire County in Massachusetts. Most of the colonies found in this latter area were small and scattered. This year there was increasing evidence that very intensive work would soon be necessary east of the zone since it was reported there were many areas of heavy defoliation over greater areas and closer to the zone than ever before.

The scouting in the season of 1928-1929 included roadside and orchard inspection throughout the entire New England section of the barrier zone as well as close tree by tree inspection at all the old sites of infestation where work had been done the previous years. Conditions were found to be better over most of Vermont and in southern Connecticut but as had been predicted and doubtless the result of wind spread from areas to the east some new and scattered infestations were found in the barrier zone in southwestern Massachusetts and northwestern Connecticut. Small additional infestations were found in New York.

During the spraying season in 1929 as in previous years all woodlands in the vicinity of new infestations were cleaned and thoroughly sprayed. (Plate XLIV) A change in the spraying equipment resulted in materially increasing the volume of work that could be done in woodland. The change mentioned consisted of dividing the spraying tanks into two compartments. This made it possible to pump the spray mixture into the hose line while the empty tank was being filled and agitated so that continuous spraying could be done. Major changes had to

be made in the valves and piping in order to achieve this result but this method worked out most satisfactorily and since that time all sprayers have been equipped with double tank construction.

A further development in spraying equipment was made this season by the equipment of a 1-1/2 ton Model T Ford truck with a newly designed power take off which proved the equal in performance of the heaviest machines. With this machine which had the advantages of light weight, ease of handling and higher road speed, it was possible to reach otherwise inaccessible locations. Pump pressures up to 1,000 pounds were possible. (Plate XLV)

Although every means was taken to thoroughly treat every infestation an increasing number of new colonies were found in the barrier zone in the late summer and early fall of 1929. They doubtless resulted from spread from large infestations east of the zone due to favorable weather conditions. In order that the woodland area in the zone could be satisfactorily examined in a shorter period of time tests were made to determine whether satisfactory scouting could be carried on by spacing the men at stated intervals in the scout line as a substitute for examining individual trees. Intervals between men in the line were tried ranging from 10 to 60 feet and it was determined that accurate work could not be done at more than 40 feet, and this was adopted as a standard for future woodland scouting operations and was used during the fall of 1929 and the spring of 1930. In some cases where the growth was extremely thick or the visibility poor the distances were reduced based on the judgment of the foreman in charge of the crew. During the winter after the leaves of deciduous trees had fallen or when the ground was covered with snow which gave favorable reflected light the foreman varied the distance accordingly. When an infestation was found an inten-

sive examination was made and the egg clusters treated and this formed the basis for a complete treatment of the area including spraying if this was necessary. All areas except forests were covered as in previous years and included examination of trees along roadsides and orchards and isolated trees in open country and along trails and forest roads.

A Federal deficiency appropriation was made available April 1, 1930 and made it possible to scout a larger area and apply treatment which otherwise would have been impossible.

It was arranged for the New York State organization to do some scouting and treatment work this year in the towns of Kent, Sharon, and Salisbury, Connecticut where several bad infestations existed near the New York State line. The expenses thus incurred were offset later by Federal work on Long Island. With the realization of the danger from spread from severe infestations east of the zone State crews were assigned by the State gypsy moth organizations in Massachusetts and Connecticut to work in that area. They performed a large amount of good work in reducing the severity of the infestation at several large colony sites.

In November 1929 a former Federal employee reported he had seen gypsy moth egg clusters on a tree near a large nursery in North Roslyn, Long Island, New York. Federal scouts were immediately ordered to make a thorough survey of the premises and immediate surroundings while scouts from the New York gypsy moth organization covered the area outside. A large number of egg clusters were found scattered about the nursery and among the trees and buildings in the nearby village of North Rosyln and were promptly treated.

On March 4, 1930 a memorandum of understanding was drawn up between the Federal Plant Quarantine and Control Administration and the

New York State Departments of Conservation and Agriculture and Markets concerning the gypsy moth work on L^{o}ng Island. The memorandum outlined the work accomplished at the colony site under the direction of the Federal office up until March 1, 1930 in cooperation with the New York Conservation Department, which resulted in close scouting of 17 square miles and destruction of over 3,700 egg clusters. The necessity for tracing to destination and inspection of nursery stock shipped from the infested area during the period since July 1926 was stressed and this was undertaken by employees of the Federal office. About 3,300 shipments were traced, over 2,600 of which were planted on Long Island. The remainder of the shipments went to other points in New York State and to 18 other States throughout the eastern part of the country and as far west as the State of Washington.

The New York Department of Agriculture and Markets agreed, as part of the memorandum, to prohibit by State quarantine the movement of any material from the infested area as determined by scouting, except after inspection and certification. It was further agreed that nurseries in Nassau County would be notified not to move trees or shrubs from their property until the premises were inspected by the New Y$_{o}$rk Department of Agriculture and Markets and certified to be free from infestation. These nurseries were inspected and then certified on March 12, 1930 and annually thereafter, and all shipments of stock were inspected and certified by a Federal inspector before removal from the premises was permitted.

It was further agreed that beginning March 1, 1930 all extermination work was to be conducted under the direction of the New York Department of Conservation. Four spraying machines were loaned by the

Federal organization for use during the following spraying season. The memorandum was signed by S. A. Rohwer for the United States Plant Quarantine and Control Administration, by H. L. McIntyre for the New York Department of Conservation, and by C. P. Norgord for the New York Department of Agriculture and Markets.

As a result of tracing the shipments, small infestations were found at Interlaken, New Jersey, and at Southhold, Douglastown and Glen Cove , Long Island. Federal scouts were sent to Interlaken and later the site of the infestation was thoroughly sprayed. The Long Island infestations were treated by New York crews.

Continued intensive work was performed at the Long Island infestation during the fiscal year 1931 and unfortunately new infestations were discovered and treated in woodlands in the towns of North Hempstead and Oyster Bay. The barrier zone work during this year was continued on the same plan as heretofore. No infestations were found at any place in Vermont where scouting was done and conditions were improved to a considerable extent in the zone in Massachusetts. A large amount of thinning and brush removal work was accomplished this year at sites of the most dangerous infestations for the purpose of removing favored food plants as well as to render further treatment less difficult. Most of these colony sites were situated in mountainous terrain and progress in spraying was greatly hindered by this fact as well as by a long period of rain during the spraying season. The unfavorable weather made it necessary to respray some sites but during the latter part of the season it was possible to complete the program as planned.

The following year work on Long Island was continued and no new infestations were found although a large amount of creosoting and

spraying was necessary at the old colonies. The barrier zone work, particularly in wouthwestern Massachusetts and northwestern Connecticut, was greatly increased. The program was expanded so that 22,000 woodland acres were given a tree by tree examination. In addition 255,000 acres were scouted by the 40 foot method in New York, north from the town of Dresden, and in Vermont. The New York scouts also used the 40 foot method and covered a large part of the zone south of the town of Dresden. No new infestations were found by either force in the area covered by this means. Federal open scouting was done in several towns in northern New Hampshire and in Maine with negative results. This latter work was performed chiefly as a check upon possible spread to the north and for data in determining the quarantine line. (Plate XLIa)

A period of unemployment began at about this time and New York State relief funds became available, some of which were allotted to the Conservation Department for gypsy moth work. Since the unemployment situation was first felt in the more thickly populated centers the funds were used largely in Westhhester County where an infestation was found in the town of Rye. This infestation was thoroughly treated and sprayed in the summer of 1932.

Quarantine

The area subject to Quarantine Notice No. 45 on account of the gypsy moth was increased on July 1, 1923 and included the quarry section surrounding Barre, Vermont. This increased area made necessary a change in districts and within the next year it was necessary to increase the permanent inspection force by three men. There were sharp seasonal increases in calls for inspection, particularly in the spring

when nursery stock was shipped and in the late fall when Christmas trees and greenery were being moved. In order to facilitate this work men were transferred temporarily from the scouting force. The regular inspectors also cooperated in their districts in the enforcement of the white pine blister rust Quarantine No. 26 on the five-leafed pine with black currant, the wheat stem rust Quarantine No. 39 on the common barberry and the satin moth Quarantine No. 53 on poplar and willow. These three quarantines did not provide for inspection or certification as they prohibited any movement of these plants from the areas under quarantine.

A hearing was held in Boston, Massachusetts in August 1923 to review the requirements for certification of nursery stock. Radical changes were made in the regulations for issuing certificates so that shippers were required to hold valid State certificates indicating that the nurseries from which shipments were to be made were free from infestation of the gypsy moth and brown-tail moth. If, upon inspection, any infestation was found on the stock offered for shipment further Federal certification was refused until the nursery had been cleaned up, and recertified by State Nursery Inspectors. A requirement was made that during the larval period movement of coniferous stock was not allowed, but this was later modified to provide during this period that all stock should be sprayed before certification.

It should be mentioned that in October of this year Mr. Harry Vinton, who had acted as first assistant to Mr. Rogers for many years on quarantine work, died and was replaced by Mr. F. W. Graves, Jr.

During the latter part of the fiscal year 1923 and the first part of 1924 the volume of shipments offered for inspection increased

sharply over the amount offered in previous years. A large part of the increase in volume was due to a substantial increase in the Christmas tree business. This was due to several causes, one of which was the Foreign ~~Plant~~ Quarantine No. 57, dated July 1, 1924, which prohibited shipment of native Christmas trees from the area in Canada north of New Hampshire, Vermont and New York and from which many thousands of trees had been shipped annually into the larger metropolitan areas in the eastern part of the United States. At the same time, beginning July 1, 1924, the movement of Christmas trees and greens from the heavily infested area was prhobitied which meant, of course, that this material shipped outside the quarantined area would necessarily originate largely in the lightly infested area. At the same time practically all the States outside of New England which had placed quarantines against New England Christmas trees lifted the embargoes and it was thus possible to enter markets previously denied the New England operators. To meet this situation practically the entire scouting force was turned over to quarantine work for the Christmas season. Nine hundred and seventeen carloads of trees were shipped and bough shipments increased 500 per cent. The amount of work thus entailed may be better understood when it is realized that one carload of Christmas trees usually requires two men for completion of inspection within one day. (Plates XLVII and XLVIIa)

Beginning in 1925 a boom in business was enjoyed and this was directly reflected upon the volume of inspection work under the gypsy moth quarantine. The report for the fiscal years 1926 and 1927 show a general increase in volume particularly in quarry products in 1926 and in Christmas trees in 1927. The increase in business in Christmas trees is rather remarkable since the quarantine revision of July

1, 1926 released a large part of the area from which Christmas trees were available in Vermont. (Plate XLVI) Incidentally the release of this area was effected to coordinate policies established in 1923 in respect to the barrier zone on the premise that exterminative treatment was applied in the barrier zone whenever infestations of the gypsy moth was found, thus obviating the necessity of inspection of products originating in that area.

In the fiscal year 1928 there was some decrease in the amount of inspection work, largely that required for certification of forest and quarry products but a very sharp increase was noticed in the amount of nursery stock inspection. There had been some mild suspicions expressed from time to time that the gypsy moth quarantine was evaded, perhaps innocently, by automobile transportation. As a check a road partol was established from September 10 to November 3, 1927 at the quarantine lines on three trunk roads through western Massachusetts. A total of 30,834 vehicles were stopped during this period but only 82 interceptions of plant products were made. In practically every case the transportation of the intercepted quarantined products was entirely innocent, and in no case was any infested material found.

During the fiscal year following the amount of inspection work was increased slightly, due perhaps to a change in the quarantine regulations effective July 1, 1928, which permitted shipment of quarantined products from the generally infested area if they originaged in the lightly infested area. Quarantine inspectors also assisted from time to time in inspecting and certifying shipments under the European Corn Borer quarantine. Beginning with the fiscal year 1930 there was a gradual decrease in the amount of shipping throughout the entire New

England area and this decrease continued throughout 1933. It is very clear, of course, that this was directly due to the depression. Quarantine inspectors also made routine inspections of tourist camps at times during the year when their regular work slackened and there can be no doubt that their recommendations to the tourist camp owners were of material benefit in preventing the spread of the insect by automobiles. Occasionally some tourist camps were found to harbor infestation of both the gypsy moth and brown-tail moth and there was some danger of caterpillars crawling upon the vehicles or luggage of campers and being carried outside the quarantined area. Tourist camp owners were very willing to cooperate since obviously a badly infested camp would be deterrent to their business.

Tabulations, showing quarantine inspections, ᴍ are not given here because the form in which reports were submitted to Washington was changed and the statistics for the latter part of the period are not comparable with those of the first part.

Although the amount and value of shipping requiring inspection and certification decreased during the latter part of this period as a result of the business depression, the yearly average number of certificates and permits issued was fully as large as during the early part of the period on account of an increase in the number of small package and mail order shipments offered for inspection.

The number of violations of the gypsy and brown-tail moth quarantine has always been small in comparison with the number of shipments requiring inspection. In practically every instance the violations were unintentional and warnings to offenders were sufficient. A few cases were prosecuted where there was evidence of willful intent

to evade the quarantine and convictions were secured. The record, however, obviously shows a general and willing compliance by the public due in great part to full sympathy with and confidence in the value of the quarantine regulations and the methods of enforcement.

PART VI

Gypsy Moth and Brown-Tail Moth Work
1933-1942

During the period beginning with the fiscal year 1933 many changes, both in personnel and management of the work,occurred. Regular funds were drastically reduced for the year beginning July 1, 1932 at a most critical time and were largely replaced in the fiscal year 1934 by emergency funds which were made available for the principal purpose of giving work to unemployed as the most serious depression in the history of the United States took place during the first years of this period. As a matter of fact, beginning in the fall of 1933 practically all the field employees on the Federal gypsy moth project, except for part of the supervisory personnel and men working from funds made available by the cooperating States, were financed by relief funds either through the ~~EMERGENCY~~ National Industrial Recovery Act, the Civil Works Administration, the Works Progress Administration, or the Civilian Conservation Corps.

A multiplicity of rules governing the administration of these agencies created considerable confusion due to the varying conditions that existed in the different States in which the gypsy moth project operated, and increased the operating difficulties of this Division materially.

On September 30, 1933 Dr. Marlatt retired as Chief of the Bureau of Entomology and On October 1, Dr. Strong, who was Chief of the Bureau of Plant Quarantine, was named to succeed Dr. Marlatt. At the same time Mr. Avery S. Hoyt, who was Assistant Chief of the Bureau of

Plant Quarantine, was appointed Acting Chief. Onl July 1, 1934 under a new reorganization the Bureau of Plant Quarantine was consolidated with the Bureau of Entomology and designated as the Bureau of Entomology and Plant Quarantine. Dr. Strong was appointed on that date and remained Chief of the new Bureau until his death in 1941. His successor, Dr. P. N. Annand, was appointed August 16, 1941.

In the spring of 1933 Mr. S. S. Crossman, first assistant in the gypsy moth Division, was assigned to supervise the management of gypsy moth work in Civilian Conseravtion Corps camps. He also directed a Federally sponsored special brown-tail moth project which was operated with funds allocated from the Civil Works Administration from December 1933 to its conclusion in February of 1934.

Another change within the gypsy moth organization was affected on January 1, 1934 when the quarantine service was transferred to the charge of Mr. L. H. Worthley. Dr. J. N. Summer, who had been in charge of this section since the retirement of Mr. D. M. Rogers in 1926, was assigned to the direction of the sub-project, Collection and Utilization of Office and Field Data. He also had charge of the assembling cage work and was responsible for compiling the periodical reports of the Bureau in Washington. He was given the further duty of administering field operations of the Federal brown-tail moth projects operated with allocated fundss of the Works Progress Administration from August 1935 to June 1937 when these projects were closed. Dr. Summers died on October 18, 1941 and his duties were then assigned to Mr. Crossman.

During this period there were several changes in the administration and among the field leaders of the work in the several States cooperating with this Division. In Massachusetts Mr. S. A. York succeeded

Mr. W. A. L. Bazeley as Conservation Commissioner and State Forester in April 1933 and was himself succeeded in 1936 by Mr. E. J. Dean. These men were largely responsible for direct cooperative arrangements made for moth work in the C.C.C. camps in the State. Mr. George A. Smith, in direct charge of the State moth work east of the barrier zone under the Commissioner, died on October 26, 1936 after many years of fine achievements in his appointed tasks. He was succeeded on September 14, 1937 by Mr. Harry B. Ramsey, who had many years of experience in moth work and continued close cooperation with the Federal office. Mr. Ramsey retired in April 1942 and was succeeded later in the year by his son, Harold L. Ramsey. Mr. Dean resigned on February 26, 1940. The Conservation Department was reorganized shortly after with Mr. Raymond J. Kenney appointed as Commissioner and under his direction with a new definition of duties Mr. Harold O. Cook was named Director of the Division of Forestry which includes the moth work within its jurisdiction.

With the death of Dr. W. E. Britton, Connecticut State Entomologist, on February 15, 1939 the gypsy moth work lost an able, most cooperative official. He was succeeded shortly after by Dr. R. B. Friend, who was for several years his capable assistant with a fine understanding of the gypsy moth problems. In Rhode Island, Dr. A. E. Stene, who was State Entomologist and closely associated with the moth work, having been in charge of the State moth program since 1905, retired in August 1940. Mr. Brayton Eddy, Administrator of the State Office of Entomology and Plant Industry, assumed the duties of the office vacated by Dr. Stene. Mr. Harry Horovitz acted as assistant to Dr. Stene from the early days of the work until 1935 when he resigned to accept other work.

Mr. H. L. McIntyre, who, as was mentioned earlier in this report, had been placed in charge of the gypsy moth work in New York when the barrier zone was inaugurated in 1923, after many years of Federal service with this Division retired on July 15, 1942. Close cordial relations were maintained with his office to the mutual advantage of the work at all times. Much of the success of the barrier zone program in preventing spread of the gypsy moth to the west of the Hudson River may well be credited to his untiring efforts. Mr. W. M. Foss, who had conducted forestry work for the Conservation Department and supervised C.C.C. camps for that Department, a considerable number of which were engaged in gypsy moth eradication, succeeded Mr. McIntyre.

In addition to the officials mentioned above excellent cooperation has existed through the years with other State officials administering gypsy moth work, including Messrs. H. L. Bailey in Vermont, E. L. Newdick in Maine, R. H. Bell in Pennsylvania, H. B. Weiss and Dr. T. J. Headlee in New Jersey, Prof. W. C. O'Kane in New Hampshire and their associates. These men materially assisted the Federal program and their attitude has been responsible for the harmonious relations so necessary for its success.

Partly as the result of a policy of Governmental economy by the Congress the Federal, gypsy moth appropriation for the fiscal year 1933 was reduced from $646,580 to $400,000. This required the drastic curtailment of plans for work in the barrier zone to a point far below what was necessary in order to make substantial progress for its maintenance, and also made it necessary to discharge more than 90 regular salaried field employees on June 30, 1932 and to furlough 39 agents for one month during the summer to keep within the funds available.

This situation was further complicated by the discovery in late July 1932 of an infestation of the gypsy moth in Pennsylvania which is referred to later in this report.

Albany Conference - October 7, 1932

These conditions were cause for alarm that further effective maintenance of the barrier zone and the immediate future of the Federal program were endangered. In order that full discussion of the situation and recommendations for a proper course of action could be devised Commissioner Henry Morgenthau, Jr. of the New York Conservation Department, called a meeting which was held in Albany, New York, on October 6, 1932. Among those present and who expressed their views during the discussion were official representatives of the following States: Connecticut, Delaware, Illinois, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania and Vermont, as well as several members of the Federal gypsy moth organization. Mr. A. S. Hoyt, assistant Chief of the Bureau of Plant Quarantine, was present and opened the discussion after an introduction by Mr. W. G. Howard, Director of Lands and Forests, New York Conservation Department, who outlined the purpose of the meeting. The writer read a paper entitled "Brief Review of the Gypsy Moth Project" which summarized the Federal work from 1940 in New Jersey and in the barrier zone following the Albany Conference of 1922. Stress was given to the amount of work accomplished and its value to the country at large, with a suggestion that one of three courses could be adopted.

"FIRST: To exterminate the Pennsylvania infestation in cooperation with that State, abandon the barrier zone, and divide the small amount of money that would be available between carrying on promis-

cuous scouting work (which in our experience is rather ineffective) in territory located somewhere west of the present barrier zone in New York, and quarantine enforcement in the abandoned area. Under this plan the present quarantine should be extended by placing the area from the east zone line to the territory where promiscuous scouting will be done, under quarantine regulations so as to protect it from shipments from the present badly or generally infested area and to protect other sections of the United States from possible infestation from shipments that come from the abandoned territory.

"SECOND: To carry through the extermination project in cooperation with the State of Pennsylvania, to maintain the barrier zone in cooperation with the State of New York, and continue the plan that has been effective for the past ten years in preventing the westward spread of the pest. This plan would mean an increase in expenditures for the emergency work in Pennsylvania and an increase over present available funds to continue the plan in the zone.

"THIRD: To follow through plan two and supplement it by the establishment of a protective area between the zone and the Connecticut River extending about as as far north as Rutland, Vermont, in order to prevent reinfestation of the zone from the east. This plan would call for additional funds. It would also give additional protection. It is believed that if this plan for future work is adopted and necessary funds made available, sufficient work can be done so that some towns on the western border of the zone may be released from time to time and more work done in towns directly east of the zone line in the section north of Rutland. Throughout a great portion of that territory millions of trees are cut every year and sold for Christmas decorations. This means considerable expense for inspec-

tion, as most of them are shipped outside the quarantined area and many of them to far distant points in the United States. By adopting this plan as territory is releases on the western side of the zone a gradual reduction of the area under quarantine could be made. This plan affords ample protection to the forest and shade tree interests of the uninfested States. It will be more expensive for a time but will result in a gradual reduction in local expenditures in the western part of the zone as territory is released.

"Past experience indicates that this plan is feasible and, based on the value of the interests involved, is a sensible as well as economical method of prctection and of preventing this perpetual drain on the natural resources of the entire United States."

Mr. W. B. Duryee, Secretary of the New Jersey Department of Agriculture, pointed out the successfully concluded extermination work in New Jersey indicated the feasibility of the work and "that it would be disastrous to abandon the Barrier Zone." Mr. H. L. McIntyre spoke briefly of the situation in New York and urged that sufficient funds should be sought "to maintain the advantage that has been gained and take care of the Pennsylvania infestation." Mr. G. H. Collingwood, American Forestry Association, also urged extension of the work and offered the services of his association in anything they could do. Representatives of the several interested States extended promises of cooperation in endeavoring to secure additional funds for Federal and State gypsy moth work. The following set of resolutions was unanimously adopted:

"WHEREAS the control of the gipsy moth is of grave importance to the entire United States, and

"WHEREAS the direct westward spread of this pest has been prevented for a period of ten years by the most efficient operation of the barrier zone plan by the Federal government with the assistance of certain States, and

"WHEREAS the recent appearance of a serious infestation in Pennsylvania necessitates the diversion of Federal funds originally intended for use in the barrier zone and really required to maintain that zone effectively, and

"WHEREAS although as State officials we realize the need at this time for the utmost economy in Federal and State appropriations, we feel that the curtailment of such appropriations should not be carried to the extreme of preventing essential control work at a temporary saving but with the certainty of a tremendous future loss,

"NOW, THEREFORE, be it resolved that the conference of State officials interested in gipsy moth control held in Albany, New York, on October 7, 1922 attended by representatives of the States of Connecticut, Delaware, Illinois, New Hampshire, New Jersey, New York, Massachusetts, Ohio, Pennsylvania, Vermont and Washington, D. C. expresses its opinion that the control of the Gipsy Moth on a nation-wide basis cannot be accomplished without the appropriation by the Federal Government of at least $300,000 to be made immediately available in addition to the $400,000 already appropriated, and this conference urges most strongly that the Secretary of Agriculture request that the Bureau of the Budget approve and that the Congress of the United States appropriate such a sum for this work, in addition to $700,000 for the fiscal year 1934.

"The following resolution relative to cooperative funds to be provided by the States for the gipsy moth project was unanimously adopted:

"WHEREAS the control of the gipsy moth is of grave importance to the entire United States, and

"WHEREAS the direct westward spread of this pest has been prevented for a period of ten years by the most efficient operation of the barrier zone plan by the Federal Government with the assistance of certain States, and

"WHEREAS the recent appearance of a serious infestation in Pennsylvania necessitates the diversion of Federal funds originally intended for use in the Barrier Zone and really required to maintain that zone effectively, and

"WHEREAS although as State officials we realize the need at this time for the utmost economy in Federal and State appropriations, we feel that the curtailment of such appropriations should not be carried to the extreme of preventing essential control work at a temporary saving but with the certainty of a tremendous future loss.

"NOW, THEREFORE, be it resolved that the conference of State Officials interested in gipsy moth control held in Albany, New York, on October 7, 1932, attended by representatives of the States of Connecticut, Delaware, Illinois, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Vermont, and Washington, D. C., expresses its opinion that the control of the Gipsy Moth on a nation-wide basis cannot be accomplished without the appropriation by each State in which the Gipsy Moth is now present, of adequate funds for control or extermination as may be feasible in the particular State concerned.

"It was decided that these resolutions should be sent to the Governor of each State, to the appropriate Departments in each State, to the Bureau of Plant Quarantine and to the National Plant Board for distribution to regional boards and their members."

As a further step a committee was appointed to act as clearing house for information, biological and financial, and the following men were named:

Dr. T. J. Headlee, State Entomologist
New Brunswick, New Jersey

Prof. W. P. Flint, Chief Entomologist
Experiment Station, Urbana, Illionois

Hon. L. E. Staley, Secretary
Department of Forests and Waters
Harrisburg, Pennsylvania

Prof. J. S. Houser, Experiment Station
Entomologist, Wooster, Ohio

Wm. G. Howard, Director
Division of Lands and Forests
New York State Conservation Department

During the winter of 1932-1933 the work in the barrier zone was further cutrailed, so that part of the very limited regular appropriation could be directed to the work in Pennsylvania, and scouting by Federal crews was confined to intensive work at potentially dangerous areas in southwestern Massachusetts and northwestern Connecticut. Several infestations were found and treated by creosoting, and this w work was followed up by spraying of 1,900 acres during the month of June with good results.

The New York Conservation Department continued its program of intensive scouting over a large section of the barrier zone in New York during the year. Two infestations were located, one at Dover and another at Milan, which were treated and then thoroughly sprayed. New York State crews also were engaged in scouting, treating and spraying the infestations in Nassau County, Long Island, as well as scouting in parts of Queens and Suffolk Counties, but no infestations were found.

In August 1933 details were worked out for a gypsy moth program to be financed from funds allotted from the appropriation for emergency projects made to the Public Works Administration under the National Industrial Recovery Act. This allotment was made available August 16 for operation in the Pennsylvania infested area, the barrier zone and territory between it and the Connecticut River.

The project was assigned by the Public Works Administration to the Bureau of Plant Quarantine and was operated by this Division. The original allotment amounted to $2,020,620.00 to be expended for labor, supplies and additional supervisory personnel during the life of the project. The amount of these funds was reduced later in the year so that changes of plan were necessary.

All workers, except supervisory personnel, were employed through the National Reemployment Service and were assigned from the counties in which it was planned to do work. Employment regulations provided that the men could be trained for scouting at selected locations best adapted for training purposes, some of which were outside the work area, and after the training period it was possible to assign and move crews from town to town as determined by the exigencies of the work.

The men were paid 55 cents per hour for 40 hours of work per week and were allowed to make up time which might be lost due to inclement weather.

By the first week in September workers were assigned to the scouting force and began to report at several infested localities where they were given special training in their duties and those found qualified were assigned to scouting crews. In order to complete as much of the area as possible and without interruption from the winter weather,

scouting was begun at first in northern Vermont and it was planned to move south as fas as conditions permitted. Crews were also assigned to scout several New York Towns within the barrier zone bordering Lake Champlain. Within a few weeks about 2,000 men were on the rolls including those working in Pennsylvania and the scouting work was at its height when weather conditions in New England became a definite hardship with severely low temperatures and heavy snowfall throughout practically the entire northern part of the barrier zone. Crews were moved south into Massachusetts and Connecticut as rapidly as possible where better weather conditions prevailed. Incidentally over 1,200 pairs of snowshoes were used on the work this winter.

The regular appropriation funds were almost entirely withdrawn shortly after the NRA work got under way and the entire field force including those under appointment were transferred to work under the NRA funds. Later in the winter it became necessary to reserve some of the NRA money to provide funds for the fiscal year 1935 and the field force was drastically reduced to affect this saving during late March and early April 1934. As a result the work as planned was only 80 per cent completed. Nevertheless, scouting on a 40 foot strip basis was completed within three counties in northern Vermont and in a large part of Massachusetts, particularly in the woodland area east of the barrier zone, as well as in Connecticut. In New York several towns bordering the southern end of Lake Champlain were carefully scouted by New York State crews, also a tier of towns in Columbia County and northern Dutchess County adjoining the Massachusetts-Connecticut State lines and in two towns in northern Ulster County west of the zone. One infestation was found in Vermont by NRA scouts.

This was in the town of Shoreham where broken egg clusters were discovered on a sled purchased and brought by a farmer from eastern Massachusetts. On the other hand, infestations in Massachusetts and Connecticut were found and treated more generally than in previous years. Around the infestations scouting was on a tree by tree basis and a large amount of intensive work was done in this fashion. Thinning work at infestations was also an important part of the program. Materials and supplies for spraying were procured with NRA funds and a total of 1,000 acres of infested woodland in the barrier zone and 7,000 acres east of the zone were sprayed during the season. Details of the work in Pennsylvania are given in a following part of this report. At the end of the fiscal year this emergency work was discontinued and all the temporary employees were dropped.

In connection with the spraying work tests were made in a limited way of the feasibility of operating spray pumps with double shift crews with the idea of utilizing the equipment for as many hours as possible during the short spraying season. Two crews were assigned to each spraying outfit, one working from 7.00 A.M. to 1.00 P.M., and the other from 1.00 P.M. to 7.00 P.M., and then alternating the time each day for seven days a week. The tests seemed to indicate the practicability of this method and the possibility of greater spray coverage by each machine each season.

Albany Conference - April 26, 1934

The great uncertainty as to the future of the gypsy moth work because of the lack of substantial funds to maintain a sustained effort to prevent the spread of the pest led the Conservation Department of New York to call another conference of official representatives of the

States concerned at Albany, New York, April 26, 1924 in order that consideration could be given to the present status of the problem and adequate provision made for its uninterrupted continuance.

The New England States, New York, New Jersey and Pennsylvania were officially represented, also Federal officials concerned with gypsy moth work, including Dr. L. A. Strong, Chief of the Bureau of Entomology, as well as representatives of the American Forestry Association, Syracuse University School of Forestry, and other interested activities.

A report concerning the status of the gypsy moth work was given by the writer, Mr. H. L. McIntyre discussed the situation in New York and the conditions in the other States were indicated by the representatives present. The successful effort which had been made to reduce the severity of the brown-tail infestation under a Civil Works Administration project was reported by Professor O'Kane and a recommendation made that this effort should be continued. A general discussion followed and the White Pine Blister Rust project was discussed in some detail by experts on that line of work at this conference.

The following report was made by the resolutions committee consisting of Dr. W. E. Britton, Prof. W. C. O'Kane and Mr. W. S. Hagar and adopted:

"Resolutions Concerning Gipsy Moth"

"The gipsy moth is recognized as one of the most dangerous insects to forest, shade, fruit and ornamental trees. On account of its European origin and because it has been possible to confine its spread in the United States to New England and to a few locations east of the Hudson River in New York State and to an isolated area of some 700 square miles in northeastern Pennsylvania and because effective methods

of control and extermination have been practiced with satisfactory results, this Conference affirms its belief that:

1. The prevention of the spread of the Gipsy Moth is of tremendous importance to the whole country.
2. Adequate maintenance of the barrier zone in eastern New York and western Vermont, Massachusetts and Connecticut is essential to the prevention of spread.
3. Reduction of infestation east of the barrier zone is a also essential to the prevention of spread, and the protection of the zone from re-infestation.
4. Eradication of the infestation in Pennsylvania is essential to the prevention of spread.
5. The maintenance of quarantine is essential to the prevention of spread.
6. The estimated cost of the above program from the Federal Treasury, in addition to monies expended by the States, for the fiscal year 1935-36, is as follows:

a.	Maintenance of barrier zone	$400,000
b.	Reduction of infestation east of zone	150,000
c.	Eradication work in Pennsylvania	300,000
d.	Maintenance of quarantine	100,000
	Total	$950,000

7. The expenditure of such funds will be a profitable investment, as in the nature of insurance of non-infested States, at a minimum premium, that it will not be necessary for them to constantly expend large

amounts of funds to control the insect, as would be the case if unrestricted spread was permitted.

8. This program will provide employment for men who need it at a time when work is scarce.

"It is the judgment of this conference that work in the barrier zone should be concentrated largely in those areas which are most subject to reinfestation by natural spread; that badly infested locations, particularly in woodlands between the zone and the Connecticut River should be sought for and treatment applied; that inasmuch as the infestation near Pittston, Pennsylvania is the most western section where the insect is known to occur in the United States, and is so located that rapid spread is easily possible, that intensive treatment should be applied in order that this infestation may be cleaned up and the existing danger from this source be removed.

"The maintenance of an effective quarantine to prevent long distance spread of this insect on shipments is very necessary."

Another resolution urging that the brown-tail moth projects be resumed under emergency funds allotments was also adopted. It is quoted as follows:

"This Conference affirms its belief that

1. Because of the damage that the Brown Tail Moth can co and because of the fact that hairs from the caterpillars poison human beings, this insect is a pest of first importance.
2. The program carried out this year in control resulted in noteworthy progress.
3. Followup of this year's program is essential in order that money already expended may not be lost.

4. An adequate followup can be accomplished at a total expenditure from the Federal Treasury for the fiscal year 1934-34, of $500,000.00, in addition to State support.
5. Such expenditure will yield a genuine return on the investment.
6. Equipment is already available.
7. The work is of such nature that it will provide productive employment for men who need work and in the winter season when other employment is a.t a minimum."

The Department of Agriculture appropriation bill for the fiscal year 1935 provided that funds would be allocated for gypsy moth scouting and control work from the money appropriated to the Public Works Administration, and for this purpose $360,000 became available in addition to a sum provided for gypsy moth and brown-tail moth quarantine activities. All of the scouting work was confined to the Pennsylvania infestation and the barrier zone since there were not sufficient funds to work elsewhere. In the Vermont portion of the zone a small amount of intensive scouting was done in a few towns in Addison and Rutland Counties. Most of this type of work was performed in the zone in southern Berkshire County in Massachusetts and in the
the northern part of Litchfield County in Connecticut at infestations found the previous year or where male moths had been caught at assembling cages during the summer of 1934. One large infestation in a solid block in Bernardston, Greenfield and Leyden, Massachusetts east of the zone was treated by creosoting the egg clusters. Approximately 280,000 egg clusters were destroyed at this infestation.

In New York practically all of the work was done by enrollees of the CCC supervised by the New York Conservation Department with some work by New York State crews at the most dangerous infested localities. A small amount of scouting and treatment work was done in a few towns in Columbia and Dutchess Counties within the zone and in Ulster County west of the zone. Most of the work by the State crews was done at the Bronx infestation in New York City which was discovered in June 1934 and in Nassau County on Long Island. CCC crews also worked on Long Island.

The feature of the year's work was a special survey conducted by 15 Federal employees to cover a large section in southern New York west of the Hudson River, at the north and south ends of New Jersey, in one county in Delaware and a part of one county in Maryland. Some State work was also done in Ohio as well as in Pennsylvania. (Plate L) The plan called for crews to average about four days in each town inspecting nursery plantings on large estates, around hotels, at camp sites, filling stations, cemeteries, dumps and any localities where movable construction equipment was stored. The survey was necessarily a somewhat superficial sort of scouting but since experienced men were used on this work and had been expertly trained it is believed that it was thoroughly done. No infestations were discovered.

In contrast to the accomplishments of the previous year only 83,000 acres of woodland were scouted in the barrier zone and only 58 acres east of the zone. The amount of spraying was reduced although 34 machines were operated. The total of 3,500 acres was sprayed during the season in the barrier zone. As part of the cooperation extended to the States 9 sprayers were assigned to the New York Conservation Department to assist in its spraying program. Double shift

spraying, two crews each employed on a 6 hour shift alternating daily, was again used in several sections with satisfactory results.

Washington, D. C., Conference - December 4, 1934

A nation--wide conference was held in the auditorium, Department of Agriculture, Washington, D. C., December 4, 1934, at the invitation of Dr. Strong, Chief of the Bureau of Entomology and Plant Quarantine, to consider the status of the gypsy moth in the United States. Twenty-one experts of the Department and officials representing the following States attended: California, Connecticut, Delaware, Georgia, Idaho, New Hampshire, Illinois, Indiana, Kansas, Maine, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Virginia and West Virginia; also the Dominion of Canada. Other interested activities were represented, including nurserymen, foresters, Florists Exchange, American Farm Bureau, tree research laboratories,insecticide manufacturers and many others; in all more than one hundred were present.

Dr. Strong indicated that the purpose of this gathering was to consider the gypsy moth problem under present conditions and that discussion was welcome as to the value and need for the prosecution of this work which had been carried on for many years in New England and adjoining States; that ideas on the subject would be given consideration but no resolutions would be permitted. Dr. F. C. Craighead, Chief of the Division of Forest Insect Investigations, presented a statement on the research work on the gypsy moth. He admitted heavy defoliation in the eastern part of the region; indicated that a definite estimate of losses due to defoliation was difficult to secure without a prolonged and continued study of trees that had been defol-

iated with the exception of white pine and hemlock, and took the ground that since 1924 no hardwoods with the possible exception of those in Barnstable and Plymouth Counties, Massachusetts had been killed by feeding alone; that defoliation retards the annual growth of trees due to loss of wood but attributed most of the injury to other causes, such as drought, fire or competition with other species; that during the period from 1910 to 1915 tremendous numbers of oaks died in areas heavily defoliated by the gypsy moth in Massachusetts and others showed gradual weakening and decline in annual growth but indicated that roots were attacked by Armellaria and the stems by Agrilus during a period of drought and compared this with death of oaks in the Middle Atlantic States and in the southern Appalachian region following the drought of 1930.

He indicated that in the Cape Cod region since 1915, where the most intensive defoliation had occurred, a marked retardation in growth in the hardwoods had been observed. Depreciation of aesthetic values due to gypsy moth feeding on park and roadside trees is a real and very tangible loss and justified preventive treatment but maintained that even in this region the insect was more important as a pest of shade or roadside trees than as a forest pest; called attention to the heavy expenditure that had been made for gypsy moth control work which in some recent years had exceeded $1,500,000 annually.

Great stress was laid on the periodicity of serious outbreaks of native insects and an attempt was made to show that the gypsy moth has assumed since 1920 the same status as native tree defoliating pests. The different types of forest regions in the gypsy moth infested territory were indicated and a statement made that in these regions where there is an overall average of not more than 40 per cent of

favored food plants that no injury would be caused, although admitting that severe damage might occur locally in some of the oak types in New Jersey, Pennsylvania, Delaware, Maryland and Virginia, and indicated that "although it would be presumptuous to forecase what would take place if the gypsy moth spread other forested areas of the Eastern States, it is reasonable to believe that these principles will still be operative and that in general the insect's behavior can be predicted."

The effect of low temperatures on the increase of the insect was discussed and a statement was made that 15° below zero is fatal to the gypsy moth larvae when they are exposed. This statment was erroneous and probably should have read "gypsy moth egg clusters", which also is erroneous. Mention was made of the effectiveness of Compsilura concinnata. Movement of the small gypsy moth larvae by wind was discussed with an indication that it was unsafe to predict the behavior of the insect in southern climates even though this pest has been found abundantly in countries bordering the shores of the Mediterranean. Reference was made to the fact that animal and plant life is restricted to so-called "definite life zones" but the limits of these zones are elastic rather than fixed and it was plainly indicated that it is unsafe to predict that damage comparable to that which is current in the most heavily infested areas of eastern Massachusetts will occur in other parts of the eastern States.

The writer gave a brief historic reference to the early phases of the gypsy moth work and traced its spread and the efforts for prevention that had been made up to the present time. This included the successful sttempt to exterminate the gypsy moth in the State of New Jersey which began in 1920, similar exterminative work which had been carried on during the years in the border territory and later in the

barrier zone which was established in 1923 and indicated the protection of the United, States, including the successful extermination of many large and small colonies, some of them located as far north as the Canadian border in Vermont, as well as successful extermination of several small outbreaks by the Dominion Entomologist's office in Canada. It was pointed out that more than 400 infestations have been exterminated in the barrier zone and in isolated outside localities. (Plate LIV)

A table was included which showed that the rate of defoliation was increasing in Worcester County and from its border to the Connecticut River. The acreage defoliated in Worcester County increased 1,965 per cent from 1933 to 1934 and between Worcester County and the Connecticut River 2,490 per cent. A brief outline of the work carried on in Pennsylvania was given and mention made of the quarantine regulations provided in that State to safeguard shipments going to other parts of the United States, also indicating the satisfactory cooperation which existed between the Federal control office and the infested States which were carrying on cooperative work on this project.

The research work had been transferred to Dr. Craighead's office in 1928 and the quarantine work to Mr. Worthley in 1934 with all data and records. From these some of the gypsy moth information prepared by Dr. Craighead had been interpreted by him and his assistants. Mr. Worthley reported that in addition to the regular gypsy moth quarantine inspection 19 road inspection stations manned by 51 inspectors had been set up and 600,000 vehicles had been stopped for inspection, 991 were reported as carrying products which were uncertified, 3 shipments were found infested, one on nursery stock from Ashby, New Hampshire to Conneaut, Ohio, one on cordwood from Pelham, Massachusetts to Port Chester, New York and another on a hemlock Christmas tree from

Seabrook, New Hampshire to Brooklyn, New York.

Mr. McIntyre was requested to make a statement relative to the work in New York. He indicated that the State had already spent $1,788,000 on gypsy moth work and the cost over the 11 year period since the zone was established was less than $1.00 per acre for the territory protected and this he stated included many acres of forest parks.

Dr. L. S. McLain, representing the Dominion Entomologist's office in Canada, reviewed the work which had been done in cooperation with the Federal control activities and successful results in exterminating the pest in Canada. Mr. Duryee, Secretary of Agriculture of New Jersey, requested the Bureau to indicate what attitude it took on the problem in order that the States might cooperate more fully. Dr. Strong stated that that was what he was trying to decide.

At the afternoon session Mr. McIntyre explained the work that had been done by the State on Long Island and clean up operations that had been carried on in infestations found in the Bronx, New York City. With reference to infestations disappearing in the barrier zone area he called attention to the large amount of intensive work that had been done which made possible this condition. He also pointed out that in spite of low temperatures and the probability that the winter of 1933 was one of the coldest on record there not exists in the Connecticut Valley this year more defoliation than was previously known there.

Several officials representing States outside the infested territory spoke in favor of continuing a strong program for quarantine and prevention of further spread of the gypsy moth and expressed satisfaction with the methods in use. These included officials from California, Illinois, Indiana, Kansas, Maryland and Michigan. Officials

charged with gypsy moth control work in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York and Pennsylvania also expressed similar satisfaction, strongly urged continuation of the Federal program and pointed out the benefits already achieved. A nurseryman from New Jersey indicated he was in favor of the work, while one each from Pennsylvania and Massachusetts objected to the stringency of the quarantine regulations. There were three representatives of forestry associations present who also indicated the work had been effective and that the volume should not be reduced.

Dr. Craighead, in explanation of a previous statement, pointed out that other insects may be neglected and asked "does it seem logical to neglect other forest pests who are killing many more trees than the gypsy moth?"

Mr. Joseph Bowman, an official of the Civilian Conservation Corps, spoke briefly on the possibility of utilizing to a greater extent the facilities of the CCC camps. The conference was closed after a statement by Mr. C. W. Collins of the Forest Insect Laboratory on the efficiency of control obtained from creosoting egg clusters and indicated that this method was not conducive of best results.

Late in the spring of 1935 negotiations were opened by the Bureau for participation in the emergency program of the Works Progress Administration. The smoothing out of details for an orderly group of projects was a tremendous task especially since necessary procedures were at times confused. Late in July 1935 allotments were granted by the Washington office of the WPA for expenditures for Federal Agency sponsored gypsy moth control work in the New England States, New York, New Jersey and Pennsylvania and for brown-tail moth work in the New England

States only. The projects were set up and the allotments were made by States so that each State was a separate project. Operation of these projects was carried on under the direction of the Bureau in accordance with WPA regulations. During the first week in August assignment of workers was made and the projects began operating with a minimum of delay, although somewhat hampered by a lack of sufficient equipment and transportation facilities. This condition was remedied as soon as possible by the purchase of a large fleet of motor vehicles but until they became available splendid cooperation in meeting the situation was given by many city, town and other local authorities who augmented the small Federally owned fleet by temporarily furnishing without cost trucks and other means for men to reach points in the field where the work was to be done. In Maine the entire region at the gypsy moth quarantine line was open scouted and several infestations which were found outside the line were thoroughly treated. Intensive scouting was done inside the lightly infested area, particularly toward the western border of the State with the successful purpose of reducing infestations which threatened uninfested areas outside. Similar scouting was performed in New Hampshire north of Lake Winnepesaukee region and a large amount of intensive scouting was done in the southern part of the State especially along the Connecticut River. Generally the same plan was followed in Vermont east of the barrier zone, although tree by tree scouting was done in the vicinity of Derby near the Canadian border, at the site of an old infestation in Rutland, and in several towns toward the south along the Connecticut River. Inside the barrier zone there was close scouting in many towns and solid woodland scouting throughout practically the entire area. Only one infestation was found,

however, and this was in the town of Essex in Chittenden County. Practically the whole barrier zone area in Massachusetts and Connecticut was scouted by the 40 foot strip method and a large amount of thinning work was done. East of the barrier zone in these States wsolid scouting was done at scattered infested locations with thinning work amounting to a large part of the program.

The project in Rhode Island covered several infestation in Washington County which incidentally was the first Federal scouting in this State for several years. The same type of work was carried on as in the barrier zone and 18,787 acres of woodland and nearly 1,500 acres in the open were scouted. A total of 72 infestations were treated and over 425,000 egg clusters were creosoted.

The project in New York was operated to scout critical towns in each of the counties within the zone and also a few towns in Albany County adjacent to the zone. A special survey was conducted again this year in New York west of the Hudson River with negative results. The territory covered included all counties in the State north of Ulster and Delaware, east of Oswego, Oneida, Madison and Chenango to the Canadian border. (Plate L) The New York Conservation Department supervised scouting at the infestation in the Bronx and in the Borough of Queens. CCC work in New York was supervised by the Conservation Department and carried on in similar fashion to the CCC work in New England.

During the spraying season 37 spraying units were in operation in the New England-New York area including 12 which were puchased with WPA funds. One hundred and eighty six tons of arsenate of lead were used in this area and a total of 4,624 acres were sprayed in the barrier zone, much of which was done with double shift spraying crews.

Over 504,000 acres in the barrier zone and 900,000 acres east of the zone were scouted intensively or by the 40 foot strip method. Six thousand four hundred and twenty two acres of woodland were thinned. Over 872,000 burlaps were applied to trees prior to the caterpillar season and approximately 649,000 feet of wire fencing were used during the spraying season.

The number of workers assigned to the project including Pennsylvania reached 3,000 by January 1, 1936 and at the beginning of the spraying season in May over 5,000 were assigned - which is the largest number of workers ever engaged at one time on gypsy moth control work. The persons assigned were obtained, with the exception of only five per cent, from relief rolls and as many be expected were in most instances entire strangers to insect control work or the hardships of outdoor work in wooded and mountainous country. Supervision was given by regular employees of this Division and by expert employees of several of the States, but at the peak of employment supervisory problems were multiplied over any previous period in gypsy moth history. In contrast to the employment regulations under the NRA, WPA crews could be employed only within short distances of their homes and could not be transferred to other sections even for training, which sometimes meant that work could not be done at some infestations if relief workers were not available within reasonable travel distance. Administrative difficulties were always present since it was necessary to deal with relief authorities and WPA administrators, each of whom in each State were more or less autonomous so that the projects in each State and sometimes in each county were operated under differing interpretations of regulations and policies. Nevertheless generally cordial and cooperative relations were maintained throughout.

A serious interruption in the work occurred in March 1936 when after a short period of warm rainy weather devastating floods swept through the river valley areas of the eastern part of the country causing great disruption in travel and enormous property damage. In many sections workers were temporarily assigned to assist in opening and repairing washed out roads, in restoring communications, and in protecting property.

Although beset with many complicating difficulties, which threatened but failed to overstrain the ability of the organization, this, the first year of WPA work was one of very satisfactory accomplishment. Unquestionably many dangerous infestations were reduced or actually eradicated which if permitted to remain untreated through another season would have required very strenuous and expensive efforts to suppress.

An additional allotment of WPA funds was made for continuance of the gypsy moth work in New York, New Jersey, Pennsylvania and in all the New England States except Rhode Island for the fiscal year 1937 but the funds were reduced later so that all WPA work for gypsy moth control was discontinued about August 1 in Maine and New Hampshire. Before the work was discontinued, however, special open scouting work was performed in many sections of Maine, especially in Washington County, where small colonies were found near the New Brunswick International Border line. A small amount of woodland scouting in this particular section was done partly by WPA workers and partly by men employed under per diem authorizations. In northern New Hampshire it was possible to complete a considerable amount of open scouting in Coos County, but no infestations were discovered in that area. The work in New Hampshire and in Maine was of particular value in that it clearly removed the sus-

picion that infestation was present in large areas beyond the northern border of the known infested territory in these States.

In the New England section of the barrier zone over one third of the entire area was covered by the 40 foot solid scouting method. No infestations were found within the zone in Vermont nor in southern Connecticut so that particular emphasis was placed on solid and intensive scouting at and in the vicinity of the more dangerous infestations in Massachusetts and in northwestern Connecticut. A large proportion of the WPA crews were engaged in solid scouting east of the zone at the infestations in Vermont, Massachusetts and Connecticut with a greater part of the work being done in Vermont in the northern half of the State. In the New York part of the barrier zone scouting was supervised by the New York Conservation Department under a cooperative arrangement and was done in several selected areas by WPA crews. A new and heavy infestation had been discovered by the use of assembling cages at Shawangunk which is in a wooded, mountainous section of southern Ulster County west of the Hudson River. Intensive work was done at this colony site and several thousand egg clusters were treated during the season. Large areas in the township of Guilderland, west of Albany, and in Fairfield County, Connecticut west of the zone were scouted by the 40 foot method but no infestations were found in either area.

Crews of the New York State Conservation Department and from several CCC camps supervised by that Department scouted large areas of the barrier zone in New York supplementing the work by WPA crews in Westchester County and on Long Island. No infestations were found north of Columbia County in the barrier zone in New York but very sizable colonies were treated in the township of Putnam Valley, Putnam

County. The source of this isolated infestation has not been determined. Also in New York WPA crews were assigned to complete the special scout throughout the remainder of the State to the west which had not been covered in the two previous years. No infestations were found.

Weather conditions throughout this fiscal year were nearly ideal. The winter was mild and it was necessary to resort to the use of snowshoes for short periods only in the most northern sections.

The number of workers engaged throughout the year was considerably less than during the previous year varying in the New York---New England area from slightly more than 1,400 to as many as 2,300 but a comparable amount of work was accomplished. Approximately 648,000 acres of territory in the barrier zone and 520,000 acres east of the zone were open scouted. There was a shart increase to over 638,000 acres in the barrier zone and 198,000 acres east of the zone of solid woodland scouting, of which 196,000 acres were done east of the barrier zone in New England. Over 3,000 acres of woodlands east of the zone were selectively thinned. There was a slight reduction in the amount of woodland sprayed. In some localities the open winter presented a fire hazard since snow cover furnishes fire protection when thinned out material is burned. To obviate this danger a machine was devised into which the brush material is placed and ground into sawdust. This machine was very efficient in operation. (Plate XLVIII)

In the fall of 1937 a few men were employed on the per diem basis from regular funds for intensive scouting work at the sites of previously located infestations in Topsfield, Machias and Calais, Maine. These men were all experienced scouts and were under regular supervision. New infestations were found and treated in the towns of Princeton and

Calais but they were small and not greatly scattered. Similar work was done at the same time across the border in New Brunswick in St. Stephen, Milltown and vicinity hby employees of the Division of Plant Protection of the Canadian Department of Agriculture, where small infestations were found and treated on 15 properties in residential areas.

The amount of money allocated for WPA gypsy moth work for the fiscal year 1938 was again reduced and less work was possible on the projects east of the barrier zone. Some open scouting was done in Vermont but a considerable amount of solid scouting was done at previously known infestations in several towns in Rutland County and in Massachusetts which were a threat to the barrier zone. Within the barrier zone selected sites throughout the length of the State in Vermont were scouted solidly with some open scouting in several towns in Rutland County all with negative results. Continued emphasis was placed on treatment and eradication of colonies in Berkshire County in Massachusetts and in Litchfield County, Connecticut.

In New York WPA crews gave intensive attention to the Putnam Valley infestation and also inspected colony sites in Amenia, East Fishkill and Cortland within the barrier zone and west of the zone solid scouting was continued in Albany County and at the Shawangunk colony in Ulster County. Considerable progress was made and many fewer egg clusters found. New York State forces and CCC crews under the direction of the State Conservation Department supplemented the New York WPA with solid scouting and treatment work in Columbia, Dutchess and Putnam Counties within the barrier zone, at several old colony sites in Westchester County including Mt. Kisco and on Long Island.

With the reduction in XXXX WPA funds the total force in New England and New York was reduced from about 2,000 workers to fewer than 700 during

the winter and increased to slightly more than 1,100 workers during the spraying season. Obviously the total amount of work accomplished was less than in the immediately preceding years and only a little over 330,000 acres in the barrier zone and 74,000 acres east of the zone were scouted by the open method and slightly less than 490,000 acres in the barrier zone and 73,000 acres east of the zone were scouted intensively or by the 40 foot strip method. During the spraying season 31 spray units were in operation and 5,000 acres in the barrier zone and 1,080 acres east of the zone were treated with spray material. Woodland thinning work was greatly reduced also, only 4,300 acres being treated in this manner. (Plate L)

One of the difficulties in operating and administering the Federal Agency WPA gypsy moth projects lay in the fact that authority for their operation and the funds available expired on June 30 at the end of each fiscal year. Prior to this date it was necessary to renew the project applications and secure approval of new projects so that there would be as little delay as possible between the end of the fiscal year and the starting of the new fiscal year. The delay or gap between projects had been insignificant until 1938 but in this year the period in which no work was possible through failure of approval of the new projects extended to as long as 11 days in Pennsylvania and only slightly less in the other States in which it was planned to work. This meant that all employees were dropped from the rolls at or prior to June 30 and that new assignments had to be made before the work could be resumed. In most cases it resulted in assignment of entirely inexperienced workers and the consequent slowdown in the nature of the work itself.

Further reduction was made in the amount of emergency funds allocated for the fiscal year 1939 and projects were started only in Vermont, Massachusetts, Connecticut, New York and Pennsylvania and with the exception of Pennsylvania practically all of the work was done within the barrier zone.

Regular appointed agents of this Division were assigned and scouted intensively at the Calais and Princeton, Maine infestations finding three small new infestations at Calais but none in Princeton which indicated that the colony in that town had been eradicated. In the early summer of 1939 the infestations at Calais were thoroughly sprayed and then the spraying crew moved into New Brunswick and sprayed the infestations within that province at St. Stephen and Milltown. This work was done in cooperation with Canadian authorities by use of a Canddian crew and a spraying machine furnished by Dominion officials. Supervision of the work and the spray material was furnished by the Federal gypsy moth Division.

Although more closely limited by reduced appropriations WPA crews accomplished a considerable amount of 40 foot strip and intensive scouting at and in the vicinity of colonies in the Vermont Section of the barrier zone as well as in a few towns of the east of the zone in Rutland County. The bulk of the work was done along the ridges of the Green Mountains, since infestations if present along such locations furnished greater opportunities for wind spread. As the result of this scouting several small infestations were discovered in Addison County. In the Vermont portion of the barrier zone there are two or three sections of very heavily wooded country which are traversed by only a few lightly travelled roads and mountain trails. These areas do not contain a very large percentage

of favored food plants and have not been too closely scouted for this reason and also because of the difficulty of scouting in such terrain. The towns of Glastonbury in Bennington County and Hancock in Addison County are typical of this kind of territory and in order to eliminate suspicion that colonies might have built up in these particular towns regular employees undertook to scout the woodlands by a method of scouting which covered the area in quarter mile strips. This method required considerable skill and knowledge of the woods since ability to follow compass directions was very essential if the area were to be properly covered. No infestations were found in the town of Glastonbury and only two infestations of one egg cluster each were found in Hancock. Similar work was done in a small portion of Rochester in Windsor County east of the zone adjacent to Hancock.

The WPA crews in Massachusetts confined their work within the zone almost entirely to intensive work at the more heavily infested colonies as well as at the heavy threatening infestations which existed in the western parts of Franklin, Hampshire and Hampden Counties east of the zone.

A distinct improvement in industrial employment conditions in the State of Connecticut was reflected by the fact that it was impossible to secure the desired number of workers from the larger towns and cities. As a result most of the work was limited to scouting and cleaning work at the colony sites in Litchfield County within the barrier zone. Small crews were available for work at a small New Haven colony and for work near Bridgeport. Late in June 1939 a rather severe and intensive infestation was discovered by employees of the State Entomologist's office in the town of Southbury in New Haven County. This was found too late in the season for spraying but some scouting

was possible to delimit the extent of the colony and burlaps were applied to the trees so that as many caterpillars as possible could be destroyed through the summer.

WPA crews in New York were busy at infestations in the townships of Phillipstown and Putnam Valley in Putnam County, in the barrier zone, but the major part of the WPA work in this State was done in Ulster County at the Wawarsing-Shawangunk colony and in Esopus where a moth was taken at an assembling cage in 1938, also at the Ticonderoga colony in Essex County which was found by scouting during the winter of 1938-1939, all of which were west of the barrier zone. A very large measure of progress was accomplished in reducing these colonies to the point of eradication. New York Conservation Department crews and CCC enrollees under the direction of the State Conservation Department supplemented the WPA work in the southern part of the barrier zone and at infestations near the Massachusetts-Connecticut State lines. These crews also undertook rather intensive scouting at Hague in Warren County, in Westchester County and on Long Island in Nassau County. The work in Nassau County was brought to a point where infestations were so reduced that immediate danger of spread from the area had ceased to exist, particularly from the nurseries, and it was decided to discontinue the Federal inspection and certification of nursery stock at time of shipment. This decision became effective on May 31, 1939. It was understood that the nurseries would be given a special inspection for gypsy moth infestation annually and if no infestation was found free shipments would be permitted.

Hurricane of September 1938

On September 21, 1938 the New England States were devastated by

a tremendous tropical storm which exceeded in extent and intensity any similar disaster that had occurred in that territory for more than 100 years.

Vast areas of forest growth were uprooted or broken down, shade trees were overturned and wrecked, and in many places practically all the trees of this type were destroyed. Buildings of all types in the path of the hurrican were wrecked in varying degrees and in many localities where the storm was most violent buildings were leveled to the ground. The storm was preceded by heavy rain of almost cloudburst proportions and as a result railroads, highways and bridges were washed out and communication was disrupted for several days. The telephone company sent fleets of rapair trucks and crews assembled at many points throughout the eastern part of the United States to reconstruct and repair lines that had been demolished. Electric power lines as well as lighting systems sustained enormous damage.

Reconstruction work which was necessary continued throughout the winter and salvage operations in the forests which were attempted by the Forest Service and the State Departments of Forestry, owners cooperating, proceeded vigorously. The supply of portable lumber mills was entirely inadequate and lakes and ponds were filled to overflowing with logs where they awaited an opportunity to be sawed into lumber as soon as possible. Even at the present time some of this lumber is still awaiting utilization. It is estimated that 2,600,000,000 board feet of lumber were blown down of which approximately 1,250,000,000 board feet were salvaged with possibly a billion board feet rendered unfit for use as a result of this storm. In most areas only pine lumber was salvaged but much of the blown down lumber trees in the more inaccessible forest areas had to be abandoned.

The path of the hurricane extended up the Connecticut Valley with a counter-clockwise, whirling motion but the damage decreased toward the barrier zone area. Scouting work was greatly impeded in some of this territory but its great importance from a gypsy moth point of view was not fully realized until scouting during the winter of 1939-1940 disclosed the presence of many new egg clusters of the insect in small numbers in woodland areas particularly in the barrier zone in western Massachusetts, Vermont and New York. The gypsy moth infestation based on defoliation records in the summer of 1938 indicated heavy deposit of egg clusters particularly in territory directly east of the Connecticut River, and from the infestations developed by scouting it was evident that a considerable spread of the insect by movement of broken egg clusters on bits of loose bark on other material which was infested had been carried by the hurricane and was undoubtedly the principal source of new infestations.

The winter of 1938-1939 was not as severe as normal and the spring was favorable for early hatching of egg clusters so that an additional opportunity for wind spread of the small larvae resulted. These two factors have been responsible for the development of many small infestations which have been found since that time not only in the barrier zone but in some sections west of the Hudson River in New York State.

The accompanying chart (Plate XLIX) indicates the path of the hurricane, direction of movements of the air currents as well as conditions of infestation which were unusually favorable for spread during that period. This resulted in the need for an unusual amount of scouting and clean up work but unfortunately occurred at the time when

emergency funds were being decreased annually on account of gradual recovery from the acute unemployment situation so that the difficulties resulting from this violent storm had tremendously unfavorable effect on the progress of the gypsy moth work.

In summing up the accomplishments of the year it has been noted that there was a sizable reduction in the acreage it was possible to thin out so that hardly more than 930 acres were treated in this manner. More emphasis was placed on intensive or woodland scouting than upon open scouting, the reports showing that 497,000 acres in the barrier zone and 75,000 acres east of the zone were examined by the former method and only 202,000 acres in the barrier zone and 29,700 acres east of the zone by the latter method. The spraying program was curtailed in keeping with the reduction in available funds in New England and New York. In the barrier zone slightly less than 3,300 acres and east of the zone 702 acres were sprayed.

Federal Agency projects were again authorized in July 1939 by the WPA for operation in Vermont, Massachusetts, Connecticut and New York but work was not resumed until two weeks after the beginning of the fiscal year. This delay was unfortunate not only because it broke up experienced scouting crews, few of which were reassigned intact, but also because many burlap bands which had been placed on the trees at several heavy infestations could not be given proper attention.

The administration of the projects was handicapped not only by a reduction in WPA funds this fiscal year but also by a rather drastic reduction of $25,000 in regular funds and unfortunately it was necessary to furlough 13 members of the regular supervisory force within the agents' class. All of these men were employees of long and loyal service and were badly needed on the project. It seems necessary to com-

ment that the appropriation was not restored and the furloughs issued to the agents became a permanent separation.

Solid woodland scouting was performed by WPA crews in Vermont within the barrier zone from Addison County north as well as at a few locations where colonies existed in lower Bennington County. Lack of labor became a stumbling block to the progress of the work in this State especially in Addison County where no WPA workers were available the latter part of the season. Travel distances were too great and WPA regulations prevented utilizing workers from areas where such help was available so that some of the work could not be done. Three rather dangerous infestations in Rutland County remained and it was possible to do a considerable amount of good work in that section. These were the only colonies where Federal WPA work was done east of the barrier zone in Vermont.

There was better availability of relief workers in western Massachusetts and although funds did not permit as large a number of assignments it was possible to perform intensive tree by tree scouting and a good amount of woodland scouting in most of the towns in Berkshire County and in many towns adjacent to the zone in Franklin, Hampshire and Hampden Counties. All of the work east of the zone was confined to the eradication of known infested colonies.

Private employment conditions continued to improve in Connecticut accelerated by the demand for war goods shortly after war broke out in Europe in September 1939 and consequently assignment of workers was reduced which also limited the work to woodland and intensive scouting at the colonies in Litchfield County and at the Southbury and New Haven colonies in New Haven County. The only exception to this was occasioned

by the discovery of a colony in West Hartford located on a height of land which offered a threat to uninfested woodland between the Connecticut River and the barrier zone. Measures were taken to open up this colony by thinning out favored food plants and this was complicated somewhat by a large amount of hurricane thrown timber.

In New York WPA crews continued eradication work at the Hague, Esopus and Wawarsing-Shawangunk colonies west of the zone in Westchester County and at Dover, Petersburg and Grafton within the barrier zone. Again this year New York State Conservation crews and CCC enrollees supplemented the Federal WPA program by scouting and treating infestations at many localities in the zone from Rensselaer County south into Putnam County. These crews also scouted a large part of Westchester and Rockland Counties and on Long Island.

The total amount of spraying accomplished was again reduced so that only 3,272 acres in the barrier zone and none east of the zone were sprayed which is less than half the amount it was possible to cover three years earlier. A feature of the spraying season was the treatment of 460 acres in Connecticut from the air by autogiro. The poison dispensed by the giro was in the form of arsenate of lead powder blended in the air with fish oil. Further details of this work are given in another part of this report. Definite effects of the 1938 hurricane became noticeable during this scouting season when many new isolated small infestations were found in the southern half of the barrier zone. There was a slight increase in the amount of acreage thinned out and a decided decrease in the amount of acreage which it was possible to scout. Five hundred and forty seven acres were thinned in the barrier zone and 160 acres east of the zone. Two hundred and fifty two thousand

acres of woodland were scouted in the barrier zone and 54,000 acres east of the zone. Two hundred and fifteen thousand acres were open scouted in the barrier zone and 13,000 acres east of the zone.

In the spring of 1940 Prof. A. G. Ruggles, State Entomologist of Minnesota and Dr. C. F. Korstian, Dean of the School of Forestry, Duke University were selected by Dr. Strong to investigate the gypsy moth problem and report their findings. This was done by visiting the office of the project at Greenfield, Massachusetts and at Wilkes-Barre, Pennsylvania, consulting the field records, conferring with the men working in the office and field, examining the different types of work and the results that had been secured, also consulting either by interview or by correspondence with State officials concerned with gypsy moth work, foresters, educators and prominent officials and citizens who had a knowledge of the work and were in a position to know its value to the country at large. This report was submitted to the Chief of the Bureau, February 3, 1941 and will be referred to later.

The authority to operate all WPA projects expired at the end of the fiscal year as usual and more than usual difficulty was experienced in securing approval for new projects for the fiscal year 1941. Final approval was not received for the work to start in New England and in New York until late in July 1940. The provisions of the WPA Act made the funds available only for 8 months and the work had to be planned accordingly. It was expected that supplemental funds would undoubtedly become available in March of 1941, although the provision of the Emergency Act in this respect was drawn up to anticipate improvement in business conditions which might obviate the necessity of relief projects where such improvements occurred. As a matter of

fact there was continued improvement in business conditions especially in Connecticut and also to a great extent in Vermont and assignment of sufficient workers to complete the program in these States could not be made. As a result the funds originally allocated were sufficient in these two States to operate for the full year. On the other hand industry in western Massachusetts did not enjoy the same increase in propserity and a sufficient number of workers were assigned so that funds became depleted in accordance with the planned eight months program. There was delay in securing supplemental funds resulting in a continuance of the program in Massachusetts and New York on a reduced scale.

In Vermont the WPA crews continued eradication work at the several colony sites found within the past few years in Bennington, Rutland and Addison Counties and it was also possible to do a fair amount of intensive work at the new colonies in the towns of Eden and Lowell in Lamoille and Orleans Counties respectively. These new colonies were very small but weather conditions and the mountainous terrain were not ideal for easy work. Cleaning work was also continued at the Mt. Holly colony in Rutland County east of the zone.

Some work of an intensive nature was possible at practically all of the colonies in Berkshire County, Massachusetts and at most of the colonies in areas adjacent to the zone but this work also was on a greatly reduced scale. In Connecticut WPA work sponsored by this Division was even more greatly limited. The number of men assigned made it impossible to cover the amount of woodland that it seemed desirable to examine and a crew of men was assigned to work in the towns of Kent and Roxbury through the courteous cooperation of the State

Entomologist's office. A small amount of work was done also in New Haven County at the Southbury infestation and it was greatly reduced in the number of egg clusters found as compared to the condition which was presented when the colony was first discovered.

WPA crews assigned to the New York project were engaged within the zone at the colonies in Berlin and Grafton townships in Rensselaer County. These colonies were small but rather generally scattered and it required considerable intensive effort to do the work. WPA crews also scouted and cleaned up infestations as time permitted in Hague, Ticonderoga, in Half Moon and In Esopus and Shawangunk west of the barrier zone. Supplemental work by the New York State Conservation Department and CCC crews under the Department's direction was done in Rensselaer County and in several counties south within the barrier zone, in the township of Colonie near Albany, in the vicinity of Ramapo, and to a very limited extent in the Catskill Mountain region. State sponsored CCC crews also dis a good measure of woodland scouting in upper westchester County and on Long Island in Nassau County.

The total amount of work accomplished during the year ending in June 1941 fell far below the accomplishments of previous years due to the reduction in funds and the lack of available competent man power. Business conditions throughout the country were now rapidly improving as a direct result of the war in Europe and the greater demand for war equipment. Naturally the younger men were finding employment in private business and most of these who remaind on the payrolls were not as physically fit or able to withstand the hardships of gypsy moth work. This year slightly over 183,400 acres in the barrier zone and 9,000 acres east of the zone were scouted by the open method and less than 229,000 acres in the barrier zone and 40,000 acres east of the

zone were scouted in the woodlands. The amount of thinning work was reduced so that only 391 acres in the barrier zone and 142 acres east of the zone were treated in this manner. During the spraying season in the barrier zone region arsenate of lead was applied to 2,000 acres. The autogiro owned by this Division was again utilized in treating remote infestations in woodland areas in Connecticut, Massachusetts and Vermont and it was possible to spray 593 acres.

The conditions which developed during this period were most discouraging relative to available funds or competent man power as the WPA personnel had been reduced as well as the supervisory force and skilled personnel.

Ruggles-Korstian Report

The report of Professor Ruggles and Doctor Korstian concerning the gypsy moth work which they investigated in the summer of 1940 was submitted to the Bureau February 3, 1941 as previously mentioned. It was anticipated that their recommendations would result in improvement of the difficult conditions which were retarding its progress.

In addition to discussing the problem as a whole they indicated their opinion that the insect had not reached its ultimate maximum spread, that it was not held back satisfactorily by natural enemies and that there were many forest environments in the west and south that are considered as more favorable for development and increase of the insect than in many of the forests in New England. They stressed the importance of spraying and silvicultural treatment of woodland areas in preference to other measures, particularly in the generally infested areas, praised the perfection to which the spraying methods and equipment had been developed and commended the progress that had

been made on the development of spraying from the air by use of autogiros. While stressing the use of indirect methods of control such as the elimination of favored food plants for the purpose of encourging tree growth upon which the insect cannot survive they recognized the necessity in the barrier zone or in isolated areas where extermination of the insect was the objective that a combination of methods was necessary in order to accomplish this purpose. They stated their belief that it was the consensus of opinion of all the men interviewed that the present barrier zone should be maintained in some manner but unless sufficient funds were available that the insect sooner or later would become established west of the present zone and that every dollar spent in preventing spread westward and southward would save many times the amount of present expenditures later on. While no authentic data are available as to exactly what would happen in the vast forests to the west and south if the insect spreads to the central hardwoods, southern Appalachian and Piedmont regions, there appeared to be no climatic or other natural barrier which would prevent such spread. They suggested the desirability of expending more funds in the southern part of the barrier zone than in the northern part as climatic conditions and food plants were more favorable in the former region.

The report recommended that a policy should be followed to prevent development of gypsy moth infestations in the zone so as to make it a permanent barrier. It is a long time program but seemed to be the best method of protecting areas west of the zone and recommended that the trapping male moths to determine the possibility of infestations should be perfected. Quarantine of the gypsy moth was commended but the question was raised as to the desirability of

permitting shipments by truck to be moved without complying with the same regulations as railroad traffic and that more rigid inspection should be given to places where motor equipment was parked or stored or tourist camps from which infestation might be carried to outside points. The need of further research was stressed to develop better control practices and to predict what would happed if the pest should be accidentally introduced into previously uninfested areas.

A need for new insecticides was mentioned particularly materials non-toxic to higher animals, and that some artificial attractant should be developed which would be cheap and more easily handled than the present one. They recommended continuance of the work on the gypsy moth and in adjacent to the barrier zone and that the program of work should be supported by considerably larger appropriations and that more publicity was advisable.

Based on information supplied to them by the United States Forest Service "the commercial species of oak in New York, New Jersey, Pennsylvania, the central hardwood region and the southern Appalachian region are estimated to aggregate over eighty-two and a half billion board feet, which, at a conservative stumpage price, would have a value of over five hundred million dollars. The financial consideration involved in the disturbance to recreation areas infested by the gypsy moth is practically incalculable. The longer the insect can be kept from these areas through whatever means possible would have decided commercial as well as aesthetic value."

Greenfield Conference - April 22, 1941

In view of the rapid decrease in WPA funds which were made available to the different States and the great decrease in the amount and

quality of labor that could be secured to work on this project, and with the regular funds available for use on the project reduced to the lowest point for many years, and because most of the seasonal information had been secured and the need for making plans for spraying was imminent, a conference was called at the Greenfield office of the State collaborators in April in order to review the existing conditions before the spring work got under way.

The conditions relative to infestations in the various States were discussed including State, local and Federal work and the labor supply that was available. It developed that in most of the New England States fewer men or less funds were available than the previous years but it was believed that a good force of competent men could be recruited if regular funds were available so that there was a reasonable prospect of regular work throughout the year.

There appeared to be no way, however, of securing such an allotment at that time although it was hoped that this condition might be remedied before intensive work was taken up in the fall or that some means could be found to augment and improve the labor supply in order that a greater volume of work could be carried on than had been possible during the past year. All those present were in sympathy with this idea.

Durham, New Hampshire Meeting - June 24, 1941

On June 24, 1941 a paper relative to the gypsy moth work with particular comments on the Ruggles-Korstian report was presented by Mr. William G. Howard, Director of Lands and Forests, New York State Conservation Department, at the summer meeting of the Northeastern Forest Pest
Disease and Insect/Control Committee at Durham, New Hampshire,

which was attended by many entomologists and foresters of northeastern United States. He commended the report above mentioned particularly the statement that "the present barrier zone should be maintained in some manner." He voiced definite approval of the barrier zone program instituted 18 years earlier as a means of preventing westward spread of the gypsy moth which had been accomplished at a reasonable cost and had protected New York State and the rest of the country west of New England. He stressed the importance of distinguishing the great difference between methods which should be used to control the pest in New England and those which should be used to prevent infestation in the areas west of New England. He stated his belief that while the silvicultural method of control is of high value to an already infested area, that he considered it distinctly secondary in connection with preventing westward spread, particularly where there are vase areas of sprout hardwoods with oaks predominating. Every effort should be made to get the owner to adjust the composition of mixed forests by selective cutting and thinning. This will greatly reduce the percentage of favored food species and the carrying out of this recommendation will go far to protect forests in the infested areas and will be helpful in maintaining the zone. Carrying out recommendations as to publicity along this line is necessary relative to information as to control methods, but we know enough now to do creditable and effective work if we can get the money to finance it, and this can only be secured by impressing on every citizen that "The gipsy moth is a pest we cannot afford to trifle with," that continued control work can ameliorate conditions in the infested areas in New England and that failure to hold the line of battle within the barrier zone means tremendous damage and vast expenditures for control west of the zone.

"Dr. Strong, shortly before his death, stated that he intended to call a meeting of representatives of various States to consider the gipsy moth problem. Many of us feel that if such a meeting could be called and if it could be given sufficient publicity both before and after, it would be effective in arousing the public to an appreciation of the gypsy moth problem. Publicity before the meeting should be directed to getting adequate representation by competent officials of practically all the States east of the prairies. Publicity after the meeting should be directed at emphasizing the points brought out during discussions at such a meeting in order that the entire country may realize the gipsy moth problem to the extent that all of us are familiar with the boll weevil, the Mediterranean fruit fly and certain other pests with which we never come in direct contact but which have been brought to our attention by adequate publicity.

"Perhaps it is not the primary function of a group of scientists and professional men, such as this, to organize publicity campaigns. Nevertheless, we can furnish the facts and possibly the inspiration to those whose talents lie along that line.

"The situation as most of you know is extremely critical at the present time owing to the seriousn infestation within the barrier zone. With the decrease in regular Federal funds for control work, with the difficulty of getting men for authorized WPA projects in gipsy moth control, with the decrease in CCC camps, the only hope for successful maintenance of the barrier zone seems to be a larger Federal appropriation. The sum of $700,000 has been suggested as the minimum for an annual Federal appropriation for work within the zone itself, in addition to such funds as may be required for other phases of Gipsy Moth control work and in addition to such relief funds as may be allocated

to these projects.

"The pioneers in Gipsy Moth control work started 35 or 40 years ago developing effective control methods and suitable equipment. They and some of the younger men initiated the barrier zone program in 1923, a program which has been carried on thus far with conspicuous success. The Ruggles-Korstian report endorses that program and suggests with good promist of success the form it should take in the future. However, to make this plan effective, it is up to each and every one of us to see that it gets adequate publicity and that no stone is left unturned to get the money necessary to carry out the program."

There was general discussion of the following resolution, all of which was favorable and it was approved and on the following day it was reaffirmed by the New England section of the Society of American Foresters.

"Resolution Adopted by New England Section of the Scoiety of American Foresters at Annual Summer Meeting, Durham, New Hampshire, June 23-26, 1941

"WHEREAS, recent heavy infestation within and adjacent to the Gipsy Moth barrier zone has created a serious situation with regard to the control of this pests, and

"WHEREAS, successful maintenance of the barrier zone is of vital importance to all States west of the zone, and

2"WHEREAS, those States will not take steps to protect themselves from the menace of this serious pest unless they appreciate the damage it can do.

"NOW, THEREFORE, BE IT RESOLVED, that the New England Section of the Society of American Foresters at its Annual Summer Meeting held at Durham, New Hampshire, June 23-26, 1941, urges the secretary of Agri-

culture of the United States or the Chief of the Bureau of Entomology and Plant Quarantine, to call a meeting in Washington at the earliest possible date to which will be invited representatives of all States east of the Prairies, the purpose of this meeting being to give serious consideration to preventing the westward spread of the Gypsy Moth."

Wilkes-Barre Conference - September 18, 1941

As no Federal conference was called in Washington, invitations were sent by Mr. W. S. Hagar, Deputy Secretary of Agriculture of Pennsylvania, to representatives of the States interested in New England, New York, New Jersey and Pennsylvania as well as to the Chief of the Bureau of Entomology and Plant Quarantine and other Government officials in Washington to attend a conference at Wilkes-Barre, Pennsylvania September 18, 1941. This meeting was held and the situation was discussed after different phases of the problem had been presented.

Dr. Annand reviewed the responsibility of the Federal Department of Agriculture in preventing spread of the gypsy moth and outlined the methods used. He summarized the expenditures since 1923 for maintaining the barrier zone and eradicating isolated infestations and expressed the opinion that work in the zone should be continued as well as quarantine measures and that the development of new materials particularly a synthetic attractant for use in assembling cages and further research concerning host relations of the insect should be undertaken.

In the absence of Mr. H. B. Ramsey, Chief Moth Suppressor for Massachusetts, Mr. Hagar summarized a paper prepared by Mr. Ramsey which gave an historical report of the work in Massachusetts. It was pointed out that the annual expenditures in that State for the preceding ten years averaged nearly $800,000 and that this represented the cost merely

for control and not for extermination of the insect.

The writer spoke briefly on experiences with the extermination project in New Jersey. Mr. William G. Howard, New York Conservation Department, gave a report on the efforts made in New York to prevent westward spread of the gypsy moth and reiterated his belief that the barrier zone had been effective but that there was a decided nmed for more scouting west of the Hudson River and that outlying infestations in that area must be cleaned up. Dr. A. B. Buchholz, Director of the Bureau of Plant Industry and Markets, New York, expressed the opinion that owing to the increased number of infestations within and beyond the barrier zone the gypsy moth problem must be considered as a national problem and of concern not only to New England but to any of the States where conditions are favorable to the insect.

Dr. E. P. Felt read a paper of considerable moment entitled "Is Maintenance of the Barrier Zone Advisable?" This latter paper was rewritten, with added data and discussion, and published in March 1942 under the title "The Gypsy Moth Threat in the United States" as Circular No. 1 by the Eastern Plant Board, at the suggestion of a committee of workers interested in the gypsy moth work.

Mr. R. H. Bell, Director of the Bureau of Plant Industry, Pennsylvania Department of Agriculture, spoke on the situation in Pennsylvania and informed those present regarding the reduction in the intensity of infestation each year since the insect was first discovered. Mr. L. G. Whitney of the Bureau of the Budget, Washington, D. C., expressed keen interest in securing first hand information regarding the gypsy moth situation so that Budget officials could act intelligently when the subject is presented to their attention. The Secretary's office, United States Department of Agriculture, was represented by Mr. La Fayette

Patterson who told of his interest in the efforts to prevent spread of the insect to other parts of the country.

Mr. H. L. McIntyre, Superintendent of Forest Pest Control, Conservation Department, Albany, New York, said he believed we can not emphasize too strongly the real danger of rapid spread of the Gypsy Moth unless measures to keep down the build up of the infestation in the present barrier zone are put in force at a very early date. The first work which should be done is that of scouting west of the Hudson River, that the actual work takes time and money, that to complete a 25-mile strip along this zone would take about $850,000 estimating the cost of scouting at 21 cents per acre. He felt certain that unless adequate funds were forthcoming at once, the infestation would build up to such a point that extermination from the barrier zone would probably never take place. He emphasized that once the Gypsy Moth gest beyond the zone and gets distributed in New York and adjacent States the people in New York as well as adjacent States will be compelled to spend much more for Gypsy Moth Control that that necessary for the cleaning of the barrier zone at present.

Mr. McIntyre was empowered to appoint a committee to take some action which would make possible the development of more support for this project. In the afternoon an excursion was made through the infested area in Pennsylvania, territory was visited where treatment work, including spraying, had been carried on and the visitors were given an opportunity to inspect the office, shop and storage facilities of the project.

The usual difficulty in securing authorization of WPA projects was greatly magnified at the beginning of the fiscal year 1942. The appropriation bill which gave life to the WPA program was not passed by the Congress until the very end of the year and not until the last moment

was it certain that funds would be allocated to operate Federal Agency projects. In its final form the bill authorized their continuation only through December 31, 1941 and the amounts made available were drastically reduced. As soon as it was possible project applications were submitted and then more than usual delay was experienced in receiving their approval so that operations did not commence on the project until the last of July in Connecticut and Vermont, until the fourth of August in Massachusetts and in New York not until the fifteenth of September. The difficulties of operating projects under these conditions which did not allow thorough planning for the full season cannot be exaggerated. The Federal Agency project work was hardly resumed in some localities before it became necessary to open negotiations for new projects to be operated under the sponsorship and field operation of this Division within the WPA program of each State under the same regulations as all State and local WPA projects. These new projects began without interruption on a calendar year basis when the Federal Agency sponsored projects were closed. In most instances the number of assignments were reduced with a consequent reduction in the amount of work it was possible to perform. This was, of course, in keeping with improved employment conditions beginning at about the time of the entry of the United States into the War on December 7, 1941 when labor shortages became most acute throughout New England particularly. The work was necessarily confined to the barrier zone except for a small amount of work east of the zone in Massachusetts.

No infestations were found north of Bristol, Vermont but on account of the small amount of WPA work done in that area this could be no indication that some infestations did not exist. For a short period two crews of men paid on a per diem basis from the regular

appropriation worked in the Addison County section during the spring of 1942. In Connecticut the State Entomologist furnished a small force for work in several dangerous spots which could not be covered on account of the lack of WPA labor and a crew of regular employees supplemented this work with a special survey. All WPA gypsy moth work ceased in Connecticut on March 31, 1942.

In New York WPA crews, which from the start of the new project in September totalled never more than 8 men up until December 1941 and thereafter never totalled more than 40 men, were able to do a small amount of scouting and cleaning work at the Hague infestation and at Esopus west of the barrier zone and at the Berlin and Petersburg infestations within the zone. New York State crews including CCC enrollees were engaged in scouting at several infestations in the lower part of the zone and west of the zone as well as Long Island. It is noteworthy that no infestations were found in the zone south of the township of Hillsdale nor at Ramapo, Shawangunk or on Long Island outside the zone.

Every effort was made to complete the spraying program of 1942 but here again the labor available prevented the maximum accomplishment. In the barrier zone only 1,900 acres were sprayed which included 1,250 acres covered by the autogiro on Canaan Mountain, Connecticut and only 83 acres were sprayed east of the zone.

It should be noted also that as a result of war conditions it was impossible to secure burlap so that with the exception of such material as remainded on hand all banding was done with tanglefoot. It was also impossible to secure the amount of arsenate of lead required.

Eighty five thousand acres in the barrier zone and 2,300 acres east of the zone were scouted in the open and only 91,300 acres in the barrier zone and 7,170 acres east of the zone were scouted in the woodlands by the 40 foot and tree by tree methods during the fiscal year.

A brief statement of accomplishments in the barrier zone and adjacent territory will be found in a later section of this report. (Plate La)

Some indications have been given of the difficulties encountered in the operation of the gypsy moth projects with funds allocated from the WPA appropriations. They should be elaborated upon in fairness to this Division and to the WPA so that proper evaluation may be given to the amount of work accomplished during the years the projects were in operation from 1935 to 1942.

Some explanation should be given, first, concerning the type and quality of the men assigned and to the conditions under which they were required to work that are peculiar to the gypsy moth control program. It is well known and recent history that in 1935 a vast number of men from all walks of life in all sections of the country were lacking gainful employment. The Works Progress Administration was established early in that summer as a means to alleviate this situation by furnishing employment on worth-while public projects. The unemployed in most desperate need were of courst family heads and included very many young, able-bodied men as well as older men of less ability. To avoid labor migrations and to prevent even temporary disruption of the family it was necessary that men should be assigned to projects only within short distances requiring no travel or residence away from their homes.

When the WPA program started it was possible for that organization to supply any number of the younger men in almost every locality within short distances from their homes to the field where gypsy moth work was needed. Of course the greatest proportion of these men were not only inexperienced but they were unfamiliar with manual work out of doors. This was not at first a serious detriment since the young men soon hardened into the physical shape necessary to do a real day's work and learned to do the job with equal facility. Yet it was often necessary to include in the same crew older men with the younger men and the average was not good. Then year by year men would leave to secure private employment, breaking up the crews generally to the extent that the work would be held back to the pace of the newest or slowest. On account of the restriction preventing transfers of men from other sections it was impossible to realign these crews more efficiently. Within a few months after the war began in Europe in 1939 industrial activity in the United States received a tremendous impetus and the younger skilled WPA workers left for private work in great numbers. This left on the rolls and available for assignment only the older men unskilled in trade or physically unfit for strenous work. Much has been written about the working conditions, meaning of course that gypsy moth work carried on by this Division is frequently located in rough wooded, mountainous terrain. Every effort is made to plan the work to avoid exposure to extremes of weather but limited time and the very nature of the country often requires that men must work in deep snow and low temperatures in the winter and in the sultry heat of summer. Young men are particularly suited for this work but experienced woodsmen or men with gypsy moth experience and ability and

knowledge of work in the woods are also preferred. When such types are not available the rate and accomplishment recedes sharply. Furthermore, with the reduction in funds year by year and the lower reservoir of available man power in what were critical areas it was often impossible to do the work most necessary to fulfill a well rounded program.

The supervisory force consisted of men with long and efficient records on gypsy moth work, most of whom were experienced in handling large groups of field men. Their job was complicated by the need for understanding and compliance with new rules and regulations often at variance with the rules and regulations of this Division and the Federal Department. Much credit must be given to these men for their loyalty and efficiency under many trying conditions.

Perhaps the greatest difficulties arose from the fact that emergency funds and the governing regulations, fiscal and financial, were controlled by an administration rather temporary in its organization with which it was necessary to reach a mutual understanding for harmonious relations. It was frequently difficult for these men to understand the problems connected with gypsy moth work because they were not familiar with the field operations. There were frequent changes in the personnel of the State WPA administrations in most of the States and changes in regulations governing the work which were necessarily inherent in any temporary organization of this type and contributed to the difficulty of uniform management of these projects.

Until January 1942 the emergency funds were allocated directly to the Federal Department of Agriculture and then reallocated to the Bureaus and Division for operation. The bulk of the funds were ex-

pended for employment of labor. In the first few years of operation the proportion was 85 per cent for labor and 15 per cent could be used for supplies and equipment if necessary to carry on the work. Later the proportion for labor was increased to 90 per cent of the funds allotted and the amount available for other operating expenses, including supplies, was based on the number of men employed. The latter arrangement caused considerable confusion because most of the heavy supplies used on this project had to be purchased under competitive biding many months in advance of the time when it would be used for operations in the field.

Even under the unusual circumstances mentioned there can be no question but that a large volume of valuable work was done in reducing dangerously threatening infestations east of the barrier zone, in eradicating or controlling isolated colonies outside the zone and that the results secured in most areas were reasonably satisfactory and fully warranted the effort. It is believed that a more workable plan would be to confine relief workers to unskilled tasks such as thinning trees, clearing brush, applying and tending tree bands and assisting on spraying work. The supervisory and scouting force should be well trained and experienced and to carry on work in many inaccessible places should be regular employees and constitute a mobile force.

The foregoing statements relative to personnel employed under emergency projects apply equally well to the Pennsylvania work which is treated separately on the following pages, and in some respects to the CCC projects which follow.

PART VII

Pennsylvania Gypsy Moth Project

Late in July 1933 a report was received at the Greenfield office that a gypsy moth infestation had been found in the town of Inkerman near Pittston, Pennsylvania. The writer immediately made a visit to the area accompanied by Mr. R. H. Bell, Chief of the Bureau of Plant Industry, Pennsylvania Department of Agriculture, and it was found that very heavy infestation existed in and surrounding that town. There were no State funds available for work there and in this emergency Federal personnel was drawn from the barrier zone in order to make a rapid survey to determine roughly how large an area was affected so that this data could be used to plan future work. Four men were detailed to do this work and found that the area affected included the city of Pittston and extended beyond it to the north, east and south. Heavy infestation was found in about 14 square miles and local infestations were found over an additional area of about 95 square miles.

A conference was held with the officials of theBureau of Plant Industry of the Pennsylvania Department of Agriculture and representatives from the State Department of Forests and Waters. In this emergency it was necessary to transfer 48 additional men from the barrier zone and during the year $78,000 of the Federal appropriation was transferred for work in that infestation. An arrangement was made between the State Department of Agriculture and the State Relief Department to allocate relief funds amounting to $100,000 so that unemployed men in the area could be given work, the arrangement was approved by the Governor and funds were quickly allotted to the relief

boards of Luzerne and Lackawanna Counties and men were furnished regularly from welfare lists. Beginning January 16, 1933 and extending to June 30 a schedule was followed, the time being staggered so that men who did satisfactory work would be employed for about four weeks. In all 1,000 men received work, an average of about 200 being employed throughout the area. They were trained and supervised by skilled Federal employees. They were assigned to cutting and burning worthless trees and brush in badly infested areas and were trained to find and treat egg clusters, climb trees and later assist in spraying work.

Federal experts carried on scouting work along the banks of the Susquehanna River to flood watermark from Ransom to Nanticoke and the Lackawanna River from its mouth to beyond the northern limits of the city of Scranton. A number of dangerous infestations were found and immediately treated. Infestations were found in Scranton, Pittston and many towns and villages as well as in the northern part of the city of Wilkes-Barre. The outer limits of the infested area covered 230 square miles but the man power was not sufficient to hastily examine a greater area. Arrangements were made for cooperation between the State Department of Agriculture and the Department of Forests and Waters on the basis of supervision and expert work being carried on by the Federal force and supplies such as spraying equipment, tools and insecticides being furnished by that office while the State Department of Agriculture would furnish as much of the supplies as possible and lease a building which was used for office and headquarters and to store equipment and supplies in the city of Wilkes-Barre.

With the small force available it was possible to work in the badly infested section of the territory and before July 1, 1933, 1,850,000 egg clusters had been treated and as there are about 400 eggs in each cluster this prevented the maximum hatching of approximately 740,000,000 caterpillars the following spring, which would have caused heavy defoliation in the area treated, and also prevented enormous spread of the pest to points outside that area. Over 1,200 acres of wood and brush land were cut and slash burned. During May over 6,000 permits for spraying were obtained from owners or tenants of infested property. Thirty eight owners who refused to grant permission for treatment were served with notices in accordance with the State law ans treatment was applied on their premises under the direction of the Pennsylvania Department of Agriculture. Twenty six high power Federal spraying machines were furnished and operated during June. Over 4,800 properties were sprayed in residential sections in addition to 2,800 acres of woodland. In one case 7,000 feet of hose was necessary to treat one remote infestation.

A study of the weather records at the Scranton, Pennsylvania station of the United States Weather Bureau covering the previous ten years indicated that when temperature conditions were favorable for spread of small caterpillars the wind ranged between north and southeast from the central infested area. The territory in which these infestations were found is rugged in character, heavily wooded except in the valleys where most of the large centers of population are located and where the principal business is mining of anthracite coal.

The results which were secured on the gypsy moth project in New Jersey encouraged the strong belief that this infestation could be exterminated. This was the consensus of opinion not only of the Fed-

eral but of the State officials, and it was believed that it was entirely practical to organize and carry on the work cooperatively on this basis. Particularly because of this infestation might serve as a center for rapid spread throughout the State and to other States adjoining. It was anticipated that the Federal Government would provide sufficient regular funds to meet this situation and that the State would furnish a reasonable share of the finances necessary to carry through a project of this type.

Results that were secured during the first year under very adverse conditions and by the employment of relief workers indicated a reasonable certainty that with a well trained force of men the objective could be reached by constant and thorough work over a period of years and that it could be more quickly and economically done by a well trained experienced force than by relief workers who were employed intermittently. The work which was necessary in the center of the infestation had been carried on advantageously with the relief men allotted.

In August 1933 funds were allotted by the Public Works Administration under the National Industrial Recovery Act for Federal gypsy moth work and an allotment was made available for use in the Pennsylvania area on August 16. Shortly after this action was taken the regular appropriation funds were withdrawn and the entire field force including all men under appointment and those on the Federal project in Pennsylvania were transferred to NRA funds. Later in the winter the allotments were reduced in anticipation that the amount withheld would be available during the following fiscal year. This made it necessary to reduce the man power in March and early April 1934 and as a result only 80 percent of the planned work was completed.

Additional scouting work was carried on along 25 miles of Susquehanna River bottom lands and 7 miles along the banks of the Lackawanna River in order to discover any new infestation that might have been brought in by flood water. None were found outside the area which was previously known to be infested.

During the year over 500,000 acres were scouted and infestations treated and 2,260 acres of woodland were selectively thinned and the brush burned in order to facilitate future work. The force was increased to about 350 workers for the spraying season and the spray material together with some other expendable supplies as well as rental of the office and storehouse were paid for from State funds. Over 4,000 acres of infested woodland were sprayed, also 3,200 residential properties. (Plate LI)

For the work beginning July 1 the only funds available were a small amount of regular Federal and State funds so that on June 30 1934 it was necessary to drop 700 temporary employees including practically the entire Pennsylvania scouting force. This was most unfortunate as the training and experience gained by these men would have made it possible for them to have performed very effective service on the project. In this emergency the State Department of Agriculture appealed to the State Relief Board who had funds which were appropriated for the purpose of furnishing work to unemployed. At that time there was tremendous unemployment accompanied by extreme suffering and destitution in Luzerne and Lackawanna Counties on account of lack of employment in the mines and the situation was so serious that funds were allotted to the relief board of Luzerne County sufficient to give employment to 200 men. They reported for work on October 24, 1934. On December 26, 200 additional men were fur-

nished. On January 28, 1935, 400 men were furnished under similar authorization to Lackawanna County. Federal and State funds were not sufficient to furnish the necessary tools and equipment to start the Lackawanna County project and arrangements were made for Lackawanna County, the city of Scranton and the Scranton-Spring Brook Water Service Company to supply and loan them to the gypsy moth project so that the work could proceed.

The projects in both of these counties were suddenly suspended the last week in February on account of lack of relief funds. They were resumed on April 8 and continued until the end of June which included the important spraying season. The Federal gypsy moth project planned and supervised the work which was undertaken and kept the records of accomplishments. The county officers assigned the men and handled the time records, payrolls, etc. The number of men varied constantly throughout the year, the highest being approximately 700. They were engaged chiefly in thinning infested woodland, doing clean up and treatment work in infestations previously found and assisting in spraying work in May and June. Only 58,000 acres were scouted during the year and a large part of this work was done by the best trained men that could be selected from these temporary employees. Twenty seven spraying machines were operated and 4,000 acres of woodland and 6,300 residential properties were sprayed.

A small amount of intensive scouting was done by the agents of the State and Bureau, fifteen carrying on a survey in the section of Pennsylvania surrounding the known infested area while State nursery inspectors made examinations in a large number of towns, particularly in the eastern half of the State, paying special attention to the

sections surrounding nurseries or in places where there was a possibility that infestations might have been brought in from badly infested areas in New England. This type of work failed to disclose any additional infestations in the State. (Plate L)

In the spring of 1935 negotiations were opened by the Bureau relaiive to securing grants from the Works Progress Administration for use on gypsy moth projects.1 A Federal WPA project was approved for Pennsylvania in July and work was begun August 12, 1935. Requests for men were placed with the United States Employment Service the same as on the NRA project. Later the requests had to be approved by the district WPA and filled by the United States Employment Service and still later all assignments were made by WPA district offices. This resulted in a delay of two weeks or more between the time requests for men were made and assignments were filled.

Employment ranged from 44 at the beginning to a maximum of 1,385, the average being 886. The project operated ten months.

There was a heavy overturn in personnel which made necessary the almost continuous training of men. Regular Federal and State funds were not increased over previous years which placed a heavy burden on the supervisory force.

At the end of the fiscal year June 30, 1936 over 154,000 acres of woodland were open scouted, 330,000 acres of intensive and 40 feet scouting performed, 2122 acres of woodland thinned, 530,000 burlaps applied, 9,461 acres of woodland sprayed, 6,500 residential properties sprayed and 132,000 trees sprayed in open areas. Two hundred twenty four thousand eight hundred feet of wire were used in erecting four strand temporary fences to prevent grazing animals from entering the

sprayed areas. One hundred fifty four tons of arsenate of lead were used which was furnished jointly by the State of Pennsylvania and by WPA funds. All woodland spraying was done with double shift crews this year for the first time in this State, after successful tests of the method on a minor scale the previous season.

Heavy floods occurred in the infested area in March 1936 and inundated roads and bridges in the valley of the Lackawanna and Susquehanna Rivers, particularly near Wilkes-Barre and Kingston which were badly flooded. Spraying machines with operators were loaned to pump out flooded cellars as a health measure. Much road and bridge repair work was necessary to enable men to get to work. The office and storehouse at this time was located at 46 Carey Avenue in Wilkes-Barre and the flood waters reached a depth covering cars and trucks in storage and prevented use of the office for several days. This resulted in a decision to move and the present office and shop site at 354 North River Street was selected. This building leased under cooperative arrangement by the Pennsylvania State Department of Agriculture is on an elevation above any possibility of flood. (Plate LII)

A new WPA Federal project for the fiscal year 1937 was promptly approved. It was the first time on any emergency work when there was no serious interruption in personnel assignments since the work in Pennsylvania began.

A special scouting program was undertaken in the early fall of 1936. This work was done along the Susquehanna River and extended from the infested area on both banks the river a distance of about 100 miles to the city of Sunbury. This was done as a check on the influence of the March floods to determine if by any change infested

material might have been carried and deposited on the banks of the river and lowlands when the floods receded.

In the course of this work six infestations were found and treated but they were all within 10 miles of the city of Pittston and well within the known infested area. No evidence whatsoever was found that the gypsy moth had been spread by the floods. After the river bottom work was completed crews were assigned to solid scouting of large areas in Wayne, Lackawanna, Luzerne, Monroe and Carbon Counties as well as a small amount of solid scouting in Pike County. A large percentage of the workers assigned were engaged in thinning work which is an important part of the program. Many of the infestations were found in brush land where it was difficult to scout and very nearly impossible to reach with spraying equipment through lack of woodroads and highways. Approximately 268,000 acres of territory were open scouted, 430,000 acres of solid woodland scouting was done and over 3,000 acres of woodland were selectively thinned.

During the spraying season 5,762 residential properties, 9,081 acres of woodland and 63,798 trees in the open were sprayed. Again this year the double shift method of spraying was used successfully.

The fiscal year 1937 project was operated for the entire 12 months period with an average number of 895 WPA workers employed. The peak of man power was 1,337 and was reached in June during the spraying season. The amount of thinning work accomplished greatly exceeded any previous year as funds were sufficient so that many areas were given much needed attention.

The WPA project for the fiscal year 1938 in Pennsylvania was approved promptly in July 1937 and only a week elapsed before a new

force could be requisitioned and report for work. The WPA funds were reduced 31 per cent and the State funds were also reduced so that it was necessary to reduce the work proportionately. A readjustment was made and, as intensive scouting and treatment seemed most essential, the selective thinning work after 1,730 acres of woodland and sprout growth had been thinned at the beginning of the season was curtailed and abandoned altogether after January 1, 1938. In the meantime a small colony had been found in the township of Damascus, bordering New York State, which had not been detected by assembling cages. It was treated and eradicated. Each year these cages were placed in suspected territory surrounding the known infested area and if male moths were trapped the surrounding territory was closely scouted during the following season.

During the late summer of 1937 land was leased at a nominal rental near Moosic where a partially completed CCC camp was located and by moving buildings in sections from another abandoned camp at Stoddardsville, all of which had been transferred to the Bureau, excellent space was provided for storage and as a center for distribution of supplies to the northern part of the working area. (Plate LIIa)

During the fiscal year over 84,000 acres of open country were scouted and 172,000 acres of woodland were examined, most of it intensively but some by the 40 foot method.

As the provisions of the WPA allotment decreased the amount of funds available for the purchase of supplies, and due to reduction in the State funds, it was deemed advisable to use burlap as a means of reduction of gypsy moth infestation in places where small colonies existed.

Following this procedure over 776,000 burlap bands were attached to trees in these localities and prior to the opening of the spraying season over 643,000 feet of barbed wire were used in temporarily fencing areas which were to be sprayed. Twenty seven sprayers were used and 92 tons of arsenate of lead were applied. This did not complete the acreage that it was planned to spray because the supply of arsenate of lead became exhausted before the normal end of the spraying season on account of the prevalence of good weather, although 5,166 acres of woodland, over 2,000 residential properties and 75,600 trees in open areas were treated.

In checking the infested areas it was determined that 38 colonies which were outside the generally infested area had been eradicated. These were located in 13 townships and led Mr. H. L. Blaisdell, who had supervision of the gypsy moth scouting and extermination project which included the Pennsylvania area, to report that "I am especially pleased with the accomplishments obtained in the Pennsylvania area and I am certain that this infestation will eventually be eradicated if necessary funds are provided to do the work which is needed to be done."

In the territory outside the area that had been placed under quarantine by the State Department of Agriculture occasional small infestations have been found to the east and northeast but immediate and drastic treatment was applied in all cases accompanied by intensive scouting in the area surrounding. All of these infestations were promptly exterminated so that there was no danger of spread of the insect from these points and an extension of quarantine was not necessary. In view of the fact that these areas were discovered in scattered locations it was deemed necessary to thoroughly scout a band of towns encircling

the quarantined area and extending to the northeast to the New York State line in order that definite proof might be secured that no infested spots existed in this outside area. Additional funds were necessary, however, so that skilled and experienced men could be assigned to this work but no money for this purpose was made available. WPA employees were not sufficiently experienced and furthermore could not be secured for this purpose because this type of work requires the men to move frequently from place to place which could not be done under the rules of the WPA. Until this is done complete assurance will not be available that no infestation exists and the success of this extermination project cannot be safely assured.

There was a delay of nearly two weeks in July 1938 before the WPA project could be resumed for the fiscal year 1939 which resulted in the loss of many of the better workers who obtained other employment during the break in operations. There was also a further reduction of about 40 percent in the funds allotted for operation of the project in Pennsylvania and plans for the year were necessarily curtailed accordingly.

The large number of burlap bands applied in the spring were patrolled by workers in the unskilled grade during July and August and many larvae and pupae were crushed. At the same time scouting crews were engaged in covering the areas adjacent to infestations previously found. Later the unskilled crews were detailed to lground work which included examining, piling and burning dead wood and forest debris as well as creosoting egg clusters at infestation centers where the clusters were sufficiently numerous to warrant use of such labor. Shortly after Labor Day the regular scouting work was started and first attention was given to the lowlands along the Susquehanna and

Lackawanna Rivers. As a result of this work only one small infestation was found which evidently had been accidentally transported to the river bank on rubbish subsequent to the previous examination of this area. For the remainder of the scouting season work was confined largely to the heavier infestations in townships within the centerally infested area. Work in the outer territory was undertaken in the nature of an intensive check up by a small force of regular employees immediately surrounding sites where moths were taken at assembling cages the previous season.

Owing to the decrease in funds and loss of experienced workers only 58,400 acres of intensive woodland scouting 24,230 acres of open scouting and 100 acres of selective thinning was accomplished which was a sharp reduction from the volume of necessary work carried on during the previous year.

The 1939 spraying season started on May 22 in the residential districts and on June 1 in the woodlands. Nearly 3,600 residential properties and 7,350 acres of woodland were sprayed which was a considerable increase over the previous year. A total of 35 sprayers was used on woodland treatment and 21 of these were operated on the double shift basis.

The fiscal year 1940 WPA project was not approved for operation until the third week in July 1939 and reassignment of workers was not made until the 25th of the month so that project operations were interrupted for over four weeks. This made it impossible to give normal attention to the more than 400,000 bands which had been placed on trees at several of the heavier infestations earlier in the season.

The work plan for the year followed largely the pattern set during previous years consisting first of a check upon areas within the older infested region and a small colony of 58 egg clusters was found and treated in Pittston. The WPA crews were chiefly engaged in scouting and necessary treatment work in sections of the centrally infested area considered most dangerous, also in similar work in the vicinity of previously located isolated infestations in outside territory and at sites of assembling cages where male moths had been trapped at the beginning of the season. This resulted in determination that 30 additional infestations had been exterminated which permitted the release of three townships from quarantine restrictions. This accomplishment is mentioned later in this report.

In October and November of 1939 Federally supervised gypsy moth projects using labor furnished by the National Youth Administration were operated in Luzerne and Lackawanna Counties providing for a total monthly employment of 320 workers. Although considerable close supervision of these men was necessary much good work was done especially in the reduction of infestations within the centrally infested area. In October a Pennsylvania Department of Public Assistance project, sponsored by the State Bureau of Plant Industry, was started in Pittston township. This did not prove to be satisfactory due to the impossibility of securing a sufficient number of workers under the rules
rules of this project who were either willing or able to do the rough labor assigned to them so that in May 1940 the project was closed.

Practically all the thinning work during the fiscal year 1940 was done by NYA or DPA workers, thus enabling the WPA crews to be concentrated almost entirely upon scouting and treatment work. There was an

average of 341 WPA employees during the year and 83,400 acres of woodland and 36,200 acres in the open were scouted which was a slight increase over the previous year. The spraying season in 1940 started on May 21 in the residential districts and on June 3 in the woodlands. Twenty eight spraying machines were operated but only 15 were used on the double shift basis and 2,351 individusl properties, 4,860 acres of woodland and 39,300 trees in the open were sprayed, which was less than in 1939, due in part to the availability of fewer WPA workers during May and June and also because WPA funds for purchase of materials including arsenate of lead were correspondingly less than in previous years.

Again in 1940 there was a delay in securing operating authority for the 1941 WPA project in Pennsylvania and it was not until August 12 that assignments of workers were finally made. This resulted in almost complete loss of the anticipated benefit from the more than 514,000 burlap bands which had been applied in May and June on trees at several critical infestations where spraying had not been possible. The delay resulted also in loss to the project of many of the more experienced workers and consequently required training of men at known infestations before scouting could be undertaken. This year a slight increase in the funds allotted for WPA work in Pennsylvania was approved but the project was set up on the basis that 90 per cent of the funds should be expended before February 28, 1941 and operating plans were made with the understanding that a further allotment would be available for the balance of the fiscal year. Beginning March 1 the force was drastically reduced, less than 70 workers being retained, but the additional funds were not made available until April 11

and on account of State WPA quota reductions requisitions for workers were not filled until late in May.

As usual scouting work was done in the early fall of 1940 along the Susquehanna-Lackawanna River bottoms and only a single egg cluster was found in Pittston township. Later scouting and treatment work by WPA employees was confined almost wholly to the area under quarantine particularly at sites of the 1940 infestations. The NYA shop and field projects were continued for the year with an average of 100 men being employed creosoting egg clusters, thinning brush lands, scouting and assisting in the spraying program. These workers were limited by NYA regulations to work within 2-1/2 miles of their assembly point which reduced their field of operations considerably. A State sponsored DPA project was again operated beginning in October 1940 and continued intermittently until late January 1941 when it was suspended because the men referred were not adequately clothed for winter work. The project was resumed late in March and finally discontinued on May 9, 1941. These workers were not permitted to be used beyond a mile from their assemble point and were therefore only employed for thinning work.

In spite of these numerous operating difficulties nearly 103,500 acres of woodland and over 33,000 acres in the open were scouted.

In May 1941 an automobile beach wagon was found infested in the town of Corry which is in the northwest corner of Pennsylvania. A few egg clusters were hatching at the time it was discovered and prompt treatment was given. Trees surrounding the immediate area were burlapped and assembling cages placed in the vicinity. Later examination in July and August revealed no evidence of the gypsy moth and it has been determined that the infestation was exterminated.

The 1941 spraying season was started in the residential districts on May 19 and in the woodlands on June 2. Since assignments of workers were far short of the number desired especially at the beginning of the season the amount of spraying accomplished was less than in 1940. Only 3,863 acres of woodland and 2,025 properties were sprayed.

In August 1941 arrangements were worked out with Messrs. R. D. Forbes and Clement Mesavage of the United States Forest Service to have several WPA workers employed under their direction on a forest type survey project in Lackawanna and Luzerne Counties do a limited amount of gypsy moth scouting incidental to their regular project assignments. These men in small parties were engaged in running strips through the woods two miles or more apart in territory outside the known gypsy moth infested area in Pennsylvania and it was hoped they might contribute something of value to the scouting work in this outside area. They were assembled at an infestation and given instructions in scouting methods and then checked while on their survey work to make certain they had understood the instructions. Shortly after on September 29, 1941 Mr. Forbes expressed his disappointment that the work could not be continued because the scouting for gypsy moth egg clusters created an additional expense to the detriment of his project which was primarily concerned with forest inventory. No infestations were found during this cooperative arrangement but the work was of value although not as comprehensive as is considered necessary on gypsy moth work.

The Federal Agency WPA projects for the fiscal year 1942 were limited by law to the period ending December 1941. WPA gypsy moth work for the remainder of the fiscal year was carried on by State WPA

program projects under Federal sponsorship on a calendar year basis and expenditures of non-labor funds were confined by the WPA authorities to expendable supplies such as arsenate of lead, fish oil, tangelefoot, creosote, etc., but not including gasoline, oil or storage for motor vehicles. More than usual difficulty was experienced in securing approval of the Pennsylvania project and the first assignments were not made until September 9. Men were not available in Monroe, Wayne and Carbon Counties where it seemed essential to check up on the possibility of outside infestations and their eradication if found, so that it was necessary to transport crews from 40 to 45 miles in order that this work might be done.

In the summer of 1941 assembling cages were placed in the territory east of the lightly infested area. Male moths were caught in Paupack, South Canaan and Salem townships, Wayne County. In the fall scouting was done in these areas and egg clusters were found. Treatment was applied and the areas were sprayed in June 1942.

Continued intensive work was carried on at colonies within the centrally infested area by WPA crews and NTA workers although the projects on which the latter were employed were discontinued in Lackawanna County on August 8 and In Luzerne County on December 3 when the men were transferred to projects deemed more directly related to national defense. These NYA men were particularly useful during July and early August for patrolling burlap bands.

Several administrative difficulties were encountered and eventually overcome when the WPA work was changed over on January 1, 1942 from the Federal Agency to the Federally sponsored set up. After considerable negotiation procedures were ironed out and increases in assign-

ments of workers were effected so that operations were running at a comparatively smooth pace in the spring of 1942.

The spraying season started on May 15 but was interrupted by heavy rains and serious floods which caused bridge washouts and consequent blocking of many roads. Water lines and reservoirs were damaged so that water shortages resulted in discontinuance of residential spraying after only 638 properties were treated. The number of workers available for spraying sharply decreased as the season progressed and the woodland acreage it was planned to cover was greatly curtailed. In spite of these odds slightly over 3,500 acres were sprayed including the outlying infestations in Wayne County mentioned above.

During July and August 1942 WPA crews were engaged in the usual post season care of spraying equipment, patrolling of burlap and tanglefoot bands and scouting and creosoting work in the vicinity of infestations within the centrally infested territory. A large part of the supervisory force was detailed to assist in the collection of Pupae in Massachusetts for assembling cage attractant material during July and August several were assigned to placing and patrolling the cages in the outside territory.

This year and in the immediately preceding years not as much work was done as had been planned or as it was desirable to do primarily because of decreasing man power available under the WPA program together with smaller, more restricted appropriations each year with which to operate. In many respects, in spite of difficulties, the progress of the work in Pennsylvania was encouraging. A large number of infestations were eradicated and there were definite indications that continued intensive work would undoubtedly result in eventual extermination of the insect in that State. (Plates LIII and LIIIa)

Pennsylvania Gypsy Moth Quarantine

One of the vital necessities if prevention of spread or extermination of the gypsy moth is to be attained is to make it impossible for the insect to be shipped to outside areas, particularly on materials on which the egg clusters may be deposited, as such movement is almost certain to start new infestations.

The worst infestations in Pennsylvania were in the center of the anthracite coal region. Few nurseries existed in the area but there was some movement of native plants such as rhododendrons and laurel, also shipping of posts, poles and other wood products such as mine props and lagging which were out in the territory and moved to various mines in the region. Most of the mines were served by railroads which had large mileages of trackage and sidings where freight cars were stored when not in active use. This covered approximately 1,065 sidings and spur lines of railroad temporarily abandoned or infrequently used on which cars were stored from time to time and which required attention. Examination showed that some of these sidings were in wooded areas where the danger of spread of the insect was very great. Contact was made with the officials of the railroad companies and the coal operators who maintained such trackage and it was agreed that no more cars should be removed or others stored until released by the gypsy moth office.

An order was issued by the State Department of Agriculture putting this arrangement into effect and excellent cooperation was worked out with the companies concerned. As soon as funds were available to employ men extensive clearing work was done at or near infested sidings so that the danger of spread by this means was eliminated and normal storage of cars was resumed.

There was ample legal authority for the Bureau of Plant Quarantine to place the infested area in Pennsylvania under Federal quarantine but in view of the satisfactory outcome of the gypsy moth State quarantine in New Jersey which covered that isolated infestation and was administeredjointly by the Federal Bureau and the State Department of Agriculture it was decided to establish a quarantine on the same basis in Pennsylvania. This arrangement was satisfactory to all concerned and on March 15, 1933 even before the entire limits of spread of the insect had been determined Quarantine No. 24 with regulations relative to movement of materials likely to spread infestation was issued by the Pennsylvania Department of Agriculture. This made it necessary for nursery stock, forest products and stone to be inspected and certified to be free from infestation before movement to points within or beyond the quarantined area, which at present under the fifth amandment to the quarantine regulations covers 980 square miles, including and surrounding the cities of Scranton, Pittston and Wilkes-Barre.

This quarantine with amendmants which were made later was issued under the authority of the Pennsylvania Plant Pest Act. Severe penalties were provided for failure to comply with the rules and a force of inspectors were provided who were drawn from the State and Federal gypsy moth force and located in five districts. Headquarters were at the Wilkes-Barre office and Mr. C. F. Campbell of the Pennsylvania Department of Agriculture, who had previous gypsy moth control experience, was placed in direct charge of the quarantine activities for that Department.

Several amendments adding to the quarantine territory and revisions up to July 1, 1937 increased the area to 1,040 square miles.

Provisions also made inspection necessary for movement of junk, particularly old metal, wood debris from buildings, and miscellaneous materials in vacant lots, as well as inspection of railroad sidings and restriction of movement of freight cars thereon.

The fourth revision of the quarantine regulations was placed in effect on February 15, 1938 and provided for a division of the territory into a "generally infested area", within or beyond which quarantined material may be moved only after inspection and certification, and a "lightly infested area", within or beyond which inspection and certification is required "except in portions of the area where infestation is not known to exist or where shipments have not been exposed to infestation permits may be issued for shipment within the lightly infested or to the generally infested area only."

The accompanying table indicates the shipments that had been inspected up to July 1, 1942 and the egg clusters found. Much of this material was moved within the State of Pennsylvania but a substantial number of shipments were destined to many other States. The number of shipments involved and the amount of infestation found clearly shows that the interceptions prevented the establishment of a very considerable number of new colonies, many of which might have gone to new areas in distant States and that the protection afforded by this work was of great interstate value.

Shipments of Quarantined Material

Year	Inspected and Certified	Under Permits	New Gypsy Moth Egg Clusters Located
1933	6,721 (Mine timbers)	--	--
1934	1,999 (chiefly mine timbers)	--	--
1935	8,698	--	70
1936	39,970	--	837
1937	80,198	--	321
1938	63,281	15,464	136
1939	32,572	41,775	85
1940	19,029	16,089	456
1941	20,075	13,364	109
1942	19,073	13,618	90

During the period the gypsy moth work has been carried on in Pennsylvania the policy followed in enforcing the quarantine has been to investigate all reported violations and it has been the policy to give the parties concerned an opportunity to fully explain their reasons for not complying with the regulations. In nearly all cases their actions resulted from ignorance or misunderstanding of the rules and unless there was willful intent in violating the rules they were given a warning in writing that any subsequent violations would result in prosecution. A total of 870 warnings have been issued and 40 offenders who did not heed these warnings have been brought to trial and in every case prosecution was successful and penalties were administered by the court.

The accompanying map (Plate LIII) delineates the area under quarantine and shows the areas including the townships of Canaan, Carbondale and Jackson which were removed from quarantine by the provisions of the fifth amendment to the regulations on November 15, 1939. This was made possible by the eradication of the insect in these areas. Further changes in the area and regulations were made December 15, 1943 by the Pennsylvania Department of Agriculture. The quarantine has been removed from 10 outlying towns and the remaining area placed under uniform certification and permit restrictions.

PART VIII

Gypsy Moth Work by CCC Camps

On March 31, 1933 an Act of Congress was approved by the President providing for useful public work to relieve unemployment and authorized conservation work on public lands, also on private lands, to control forest fires and forest tree pests and diseases. This work was placed in charge of the Director of the Civilian Conservation Corps. The United States Forest Service was authorized to handle the forest phases except in National parks and recreational areas which were supervised by the Department of the Interior. State foresters in each State were charges with general management of the forestry camps as soon as they were built and for proper programs of work.

The Bureau of Entomology and Plant Quarantine participated in these programs, the work of the gypsy moth division being confined to the States of Vermont, Massachusetts and Connecticut with a few camps in western New Hampshire. Mr. Crossman was placed in charge of the gypsy moth camp projects and a detailed plan was prepared to fit into the varying activities covered in each State forester's plans.

The organization was developed and decision was reached to carry through a gypsy moth program for as much work as possible between the barrier zone and the Connecticut River with some additional work east of the river in New Hampshire, Massachusetts and Connecticut in areas where heavy infestations existed. Several camps were also established for gypsy moth work in New York under the direction of the State Conservation Department and thw work which was done by them has already been mentioned. Later an attempt was made to secure camps in Pennsyl-

vania. Two were partially built but a rearrangement of CCC plans made it impossible to operate them and they were transferred to the Bureau of Entomology and Plant Quarantine and used for storage purposes. All camps were located either in State property or on land leased from the owners and were situated so as to be most convenient for the State foresters' general program.

Before the close of 1933 eighteen such camps were established from which allotments of men were assigned for gypsy moth work. Supervision and technical direction of the work was handled by Mr. Crossman from the Greenfield office of the gypsy moth project and from time to time a limited number of supervisors and agents were detailed to train and organize this force so that effective methods of treatment could be put into operation. Supervisors with long experience on gypsy moth work were selected to form a part of the camp organization and experienced foremen were provided by the camp management. This was necessary in order that enrollees might have proper direction in carrying on the project and as the enlistment was limited to a six months period which in some cases was extended there was a rather rapid turnover in personnel.

The working day was six hours and this requirement curtailed materially the volume of work that could be done. From time to time enrollees were transferred from this work to other camp activities and it developed that some of the areas where gypsy moth work should be done were inaccessible on account of the location of the camps.

Later more camps were established and on account of the drastic reduction in the regular gypsy moth appropriation effective July 1, 1932 which had made it necessary to discharge a large number of the

gypsy moth agents of the Bureau it was possible to utilize a considerable number of these men in the camp organization. Transportation was furnished by each camp and tools and supplies were also provided. The limitation on the time of travel from the camps to areas where work was done restricted the operating areas so that in many cases it was impossible to carry on complete scouting and treatment work and cover whole towns or counties.

In 1934 the number of camps was increased and several were transferred from the Forest Service to the management of the Department of the Interior and in some of these camps work was carried on in park and recreational areas under the same gypsy moth supervision from the Bureau.

The work consisted of scouting in infested or other areas which were under suspicion on account of their location or the favorability of the tree growth, thinning woodland in infested areas by elimination of species favored by the insect and the removal and burning of worthless growth, creosoting egg clusters and destroying caterpillars on trees where burlap or tanglefoot bands had been applied. No spraying was applied during the early years of the program as necessary equipment was not made available by the CCC and existing equipment of the Federal gypsy moth project was urgently needed in outlying infested territory.

Later in the period of CCC work some spraying was done by ground machines some of which were furnished by the Connecticut State Entomologist's office supplemented by others that could be spared from the Federal gypsy moth project. Most of the insecticides required were provided by camp organizations who supplied the labor for this work.

Some acreages were treated by using a Federal autogiro.

The CCC gypsy moth work was operated from 1933 to September 3, 1941. The largest number of enrollees employed on this work was 2,300 in 1935 and they were assigned from 50 different camps.

A yearly average of 14,075 six hour man days was used and 580 men were employed per year. This produced an average of 450,875 acres examined each year. During the entire period 35,000 isolated trees were removed, 2,300 acres of woodland thinned and treated and it was estimated that over 73,000,000 of the insects as egg clusters or in other stages were destroyed. In addition to this over 5,000 acres of woodland were sprayed.

This work had a very beneficial effect in checking infestations east of the barrier zone and many colonies large and small were eliminated and in the woodland areas where it was possible to do clean up work the danger of spread toward the west was materially reduced.

More than 11,000 enrollees were given useful employment in time of stress with direct benefit to themselves and to their families and the majority were rated as worthy of reemployment.

PART IX

Gypsy Moth and Brown-Tail Moth Quarantine

Attention has been called to the gypsy moth and brown-tail moth quarantine which was promulgated as Quarantine No. 4 on November 5, 1912 by the Federal Horticultural Board under authority of the Plant Quarantine Actof 1912. Its purpose was to prevent the spread of these insects on shipments of plants, plant products and other materials that were moving to points outside the infested area, and provided for inspection and certification of the shipments by a Federal inspector at the point of origin before they could be moved. Shipment without inspection was permitted within the infested area. Numerous amendments to the quarantine regulations were made from time to time modifying the quarantined territory and the conditions under which inspections were made. One of the most far reaching changes was made in 1916 when the quarantined area was divided and designated as a light infested area and a generally infested area, with free shipment permitted from point to point within each area from the lightly infested area to the generally infested area, but requiring inspection and certification of shipments from the generally infested area into the lightly infested area and from either the generally infested area or the lightly infested area to points outside the quarantined territory. This was provided because it had developed that in some cases, under the first regulations permitting free shipment throughout the quarantined area, towns within the area which had been cleared of infestation were reinfested by shipments from infested towns.

Shipments under permits, which had the effect of certificates,

were provided for when quarantined products originated in the outside area but were shipped from points within the quarantined area to points outside. Also permits were issued for use in shipments of quarried products or other materials that have been manufactured, processed, or stored in such manner that, in the justment of the inspector, no infestation could be transmitted. This resulted in better service to shippers of these types of materials without relaxation of quarantine requirements.

Developments and refinements in the gypsy moth and brown--tail moth quarantine are referred to in other parts of this report as well as amandments affecting the extent of the area under quarantine. No major changes have been made in the area or the regulations since January 1, 1934 when the work was transferred from this Division and Notice of Quarantine No. 45, effective July 1, 1920, as amended by changes in area from time to time since, has remaind in effect to the present time.

The general administration of quarantine activities and duties of the Federal Horticultural Board were taken over by the newly organized Plant Quarantine and Control Administration on July 1, 1928. This included issuance of amendments to regulations for enforcement of the gypsy moth and brown-tail moth quarantines. When the reorganized Bureau of Entomology and Plant Quarantine was established on July 1, 1934 the regulatory administration of the plant quarantine act was assumed by the new Bureau where it has since continued.

It has been obvious that this phase of the work is essential to safeguard uninfested sections of the United States and give them adequate protection from receiving infested shipments. The effective-

ness of the quarantine has been unquestioned, the large number of infested shipments offered for inspection and destined for points all over the country is a definite indication of the possibility of spread that has existed but which has been prevented by this work.

Violations of the quarantine have been reported from time to time but based on the total number of shipments inspected the percentage has been very small and in practically all cases evidence of willful intent has not been found. In the very few instances where violations appeared to be intentional or persistent vigorous prosecution has been undertaken and convictions have resulted. It is a fact that there has been general compliance with the quarantine regulations which is perhaps the best indication of popular approval of the measures and means taken.

PART X

The Barrier Zone

The gypsy moth control problem during the years resolved itself into three main projects, two large exterminative projects in outlying territory, viz: New Jersey and Pennsylvania; and a third, the barrier zone to prevent westward spread.

The New Jersey project was successful after an intensive struggle for more than ten years involving work covering the entire State and intensive activities in about one third of its area. (Plate XXXVIII) Extermination was achieved because of the effective cooperation with the State, efficient organization of the force, prompt action by highly trained personnel and sufficient finances to operate without delay and lost motion. This result proved that extermination of the gypsy moth from a large area is possible, confirmed the contention of the Massachusetts officials that it could be done and that the measures undertaken were entirely feasible.

The Pennsylvania project which, with the exception of the relatively meager appwopriations from State and regular Federal funds for supervision, was organized and operated by utilizing emergency relief funds at security wages to relieve unemployment and with intermittent temporary employees who could not work except relatively near their homes, and which has not only checked but reduced the area infested and has prevented visible damage since the work was fairly under way, bids fair to accomplish an exterminative job and relieve not only the State but those surrounding from infestation. Although the area remaining to be done requires work in much difficult mountainous terri-

tory embracing over 2,500 square miles the best informed experts believe this can be brought to a successful conclusion if sufficient trained personnel can be made available and the work continued until completed. (Plate LIII)

Due to the increase in infested locations beyond the border of the known infested area in New England and with the beginning of the New Jersey project in 1920 when it became necessary on account of the size of the latter area to concentrate a large proportion of the field force in New Jersey, the work in New England, particularly in the area bordering the Connecticut River, had to be curtailed. This made it impossible to carry on sufficient work there to determine the conditions of infestation and do the necessary treatment except in the most dangerous areas.

The information secured up to the fall of 1922 indicated clearly the danger of unlimited spread toward the west which was facing the gypsy moth project as small infestations had been found in many towns as far west as the New York State line and in a few towns in New York directly west of the Vermont-Massachusetts State line.

This matter was taken up at a conference held in Albany, New York November 16, 1922 when the whole situation was reviewed and discussed thoroughly, as well as the progress that was being made in the initial work in New Jersey, and the action which was taken clearly indicated there was a consensus of opinion that a barrier zone of some sort should be established with the purpose of keeping it as clear as possible of gypsy moth infestation and preventing further westward spread.

Details of the work which was carried on since the establishment of the zone as well as that of New Jersey and Pennsylvania have already

been given in previous parts of this report. New York funds were made available in the spring of 1923 and work was begun there in April of that year. Federal work was begun on July 1. In the territory east of the line which was established in the New England States the work was turned back to the States. The Federal work was conducted between that line and the New York border and in New York State it was believed at that time that the State itself, after the work had been properly organized in cooperation with the Federal office, could take care of existing infestations in that area.

Enough scouting work was carried on in the fall of 1923 so as roughly to determine the approximate boundaries of the zone. (Plate XLI) During the next few years open scouting was carried on throughout the zone and intensive treatment work applied in all colonies found. From 1925 to 1927 due to the finding of the Henrysburg colony and several small isolated colonies in northern Vermont and many small but threatening infestations within the zone in western Massachusetts and northwestern Connecticut near the New York State line, it seemed desirable to carry on some scouting work east and west of the zone in the areas as shown on Plate XLI. All of the infestations indicated on the map were promptly eradicated but a considerable amount of inspection was necessary from time to time west of the Hudson River as a precautionary measure.

The colony found at Henrysburg, La Colle township, Quebec, was found and eradicated by the Dominion Entomologist of Canada, and additional scouting was conducted under his direction along the International border to the Connecticut River. No additional infestation was found.

By 1927 there were indications that infestation of the area east of the barrier zone had increased and presented a distinct threat to the efforts expended in preserving the zone as a bar to spread of the insect to the west. A vigorous attempt had been made in 1924 and in the years following to secure additional funds for suppressive work in the territory east of the zone to reduce the threat and protect the zone from possible reinfestation. Careful estimates for the minimum funds needed and detailed statements in justification of the requests were submitted but none were provided. Before the end of the fiscal year 1932 most of the dangerous part of the zone in New York, areas on Long Island, and in the territory south of the zone in New York had been closely examined at least once and infestations treated by State forces, and similar work had been done in the New England area and in the northern part of the zone in New York by the Federal force with the exception of small areas in southern Connecticut and northern Vermont. A plan to scout the entire zone area once every three years and treat the infestations when found was put in operation but this procedure was interrupted by the sharp decrease in appropriated funds for the fiscal year 1933 and by the necessity for diversion of funds to the Pennsylvania infestation. As a result the amount of scouting and treatment work in the barrier zone was greatly curtailed and confined to intensive work at the most dangerous known infestations.

Since 1933 practically all of the work except supervision has been financed by emergency funds under the NRA, CCC and WPA. While the Federal office supervised this work the rules under which each of these organizations operated carried with them requirements which made

it difficult to examine and treat territory in many of the sparsely settled areas. The NRA regulations gave the greatest latitude in that respect but these arrangements lasted only for a little less than one year. Under the other organizations there was an abnormal turnover in manpower which made it difficult to retain the continuous services of men who were sufficiently trained to do expert scouting work. It was possible, however, under the NRA and CCC programs to carry through in the fiscal year 1934 a large volume of long recommended and very necessary work, particularly in the area between the zone and the Connecticut River in Connecticut and Massachusetts where many infestations were found, as well as in eastern and central Vermont and in the northern part of that State nearest the barrier zone. The CCC and NRA work in New York beginning in 1933 was directed by the Department of Conservation. Only a moderate amount of woodland scouting was done by these Federal agencies up to 1934 and most of this was carried on in the northern part of the zone in that State. (Plate L)

The work was again limited in the fiscal year 1935 when funds were small following the closing of the NRA program and prior to the period of WPA operations which began in August of that year. It was again necessary to restrict the barrier zone scouting and treatment program to the vicinity of the more dangerous colony sites where possibility of wind spread to the west was greatest.

The best advantage was taken to fully utilize the large sums allocated for Federal Agency WPA projects beginning with the fiscal year 1936 and a very substantial acreage was closely scouted throughout the barrier zone and in territory adjacent to the zone in New England.

After 1937 the funds allotted for emergency projects were annually reduced which curtailed the number of men that could be employed and increased the turn over of personnel so that the efficiency of the men was greatly reduced. A five year plan for scouting in and adjacent to the barrier zone had been considered to insure coverage of the area at stated intervals but with the reduction in funds and the fact that in some areas prior to 1940 it was impossible to secure the number of men necessary to do the work which should have been done because the men listed as available had returned to their regular employment the plan could not be put into full effect.

It was thoroughly appreciates that although the largest amount of work was being done with the resources available that the necessity for regular funds was urgent to replace WPA allotments so that a mobile force of trained and experienced men could be maintained with a minimum amount of turn over because, as is always the case on temporary work where the pay is low and the opportunity for continuous work is uncertain, the most efficient workers are able to secure more remunerative jobs in which they have had experience whenever industrial activity increases. Efforts were made to secure additional funds from regular appropriations on several occasions without satisfactory results and of necessity the project suffered.

Mention has previously been made of the results of the hurricane in September 1938 not only on account of the devastation it caused in the forests by making field work more difficult, as the result of leaving many woodlands areas covered with blown down trees and litter in the wake of its destructive path, but also by the fact which was later demonstrated that infestation brought by the carriage of broken

egg clusters upon debris or othermaterials must have been carried long distances by the tremendous air currents which spread over the devastated area. When minute gypsy moth larvae are spread by air currents there is a tremendous amount of mortality because the larvae are dispersed and a very large proportion of them fall on areas where no suitable food is available. In the case of the carriage of eggs, particularly if a single egg cluster or a portion of it comes to rest in one spot, the opportunity for survival of the species and more rapid increase is far greater than if a single wind blown larvae becomes established at a single point. Although conditions in the spring of 1939 were favorable for the movement of small larvae by wind currents the survival and build up of infestations that resulted from the hurricane were more quickly noticeable. The scouting work in 1940 resulted in the discovery of many very small scattered infestations in the zone and which were in direct line with the general movement of the air currents of the hurricane itself.

In 1941 a few colonies were found in New York State west of the barrier zone and during the spring of 1942 the number discovered was somewhat increased. It seems entirely possible that the full effect of the hurricane has not yet been fully realized nor determined and this has been complicated by the difficulty of attempting to find these infestations with the small number of skilled men available. The CCC was discontinued and very few men were available in 1941 and 1942 to carry on this important work.

In spite of the difficulties encountered it appears to be generally recognized that the efforts expended for maintenance of the barrier zone as a means of preventing spread of the gypsy moth to

the west into New York State and beyond have been successful. Korstian and Ruggles stated in their report dated February 3, 1941 which reviewed the gypsy moth work that "it is our belief and the consensus of opinion of all men interviewed that the present barrier zone should be maintained in some manner ..... for every dollar spent now in holding back the westward and southward spread of this pest, many times the amount of present expenditures will be saved." At the meeting in Durham, New Hampshire on June 24, 1941 of the Northeastern Forest Disease and Insect Pest Control Committee, Mr. William G. Howard of the New York State Conservation Department commented on the Korstian-Ruggles statement, pointing out that "this statement constitutes a definite approval of the barrier zone program initiated 18 years ago (1923) as a means of preventing the westward spread of the Gipsy Moth. While all of us realize that certain factors may arise which may make it impossible to maintain this zone forever, there can be no doubt that its maintenance for the past 18 years have been accomplished at a reasonable cost and that the funds expended have afforded protection to New York State and to the rest of the country west of New England at the lowest possible cost." (Plate LIVa)

These statements are clearly backed up with the fact that no infestations spread by natural means have become so firmly established beyond the zone since 1923 but that eradication has been possible shortly after prompt and intensive measures were taken. Lack of sufficient funds and experienced personnel may at the present time result in conditions which will offer a serious threat to the continued integrity of the barrier zone but experience seems to have shown that if the necessary funds and personnel are available its value and effectiveness can be continued.

From time to time other infestations have been discovered west of the barrier zone all of which were promptly eradicated as shown on Plate LIV. None of these were the result of natural spread.

PART XI

Emergency Brown-Tail Moth Work

Federal CWA Project

Unemployment conditions throughout the country reached an alarming state in the fall of 1933 and caused great hardship the following winter. In an effort to overcome so far as possible this serious threat large sums of money became available through Congress for relief projects which were administered by the Civil Works Administration.

The Bureau of Plant Quarantine was asked to participate in the Civil Works program and in view of the fact that the brown-tail moth infestations had increased alarmingly to epidemic proportions particularly in Maine and New Hampshire and to a less extent in Massachusetts approval was secured December 1, 1933 for a brown-tail moth extermination project for operation in Maine, New Hampshire, Vermont and Massachusetts. Funds were allocated in the amount of $870,850 which it was estimated would provide employment for about 5,000 men during the life of the project. The project was hastily organized by the Division headquarters at Greenfield with active cooperation and the full support of the State officials and local moth superintendents in the cities and towns of the brown-tail moth infested area. Workers reported through assignment by the National Reemployment Service about the middle of December. The field work was directed by the State officials who handled gypsy moth control operations under general supervision of the Greenfield office. Since it was impossible to purchase supplies with CWA funds at the time of starting the project, necessary equipment such as ladders, pruners and

other tools was furnished very largely by the Federal office in Greenfield and by the States concerned.

The work was carried through in spite of weather conditions which were the most severe for many winters but unfortunately the project was discontinued on February 15 when approximately seventy five percent of the authorized work had been completed and slightly over $515,000 of the allocated funds had been expended. During this short period of about two months in which an average number of 4,506 men were employed a total of 908,341 hours many millions of brown-tail webs were cut and destroyed and in addition over 183,000 worthless tress, principally apple, of no commercial value were removed as further source of brown-tail moth reinfestation.

While it was very unfortunate that this project could not be continued until spring at least its great value in reducing the potential damage by the brown-tail moth cannot be overestimated. It is conceivable that if the project could have been continued and pressed vigorously the eventual eradication of the brown-tail moth was highly possible. In New Hampshire, where practically half of the webs were found and destroyed, the work was continued by means of a State sponsored CWA project during the season until the caterpillars began to emerge from their winter nests, and an additional 3,900,000 webs were cut and destroyed. (Plate LV) There were a considerable number of towns in which 200,000 to 300,000 webs were destroyed and many more where as many as 40,000 to 50,000 or more were burned. The infestation of the brown-tail moth in Vermont was generally very light and scattered but there is no question that this work removed a serious threat of future build up in the brown-tail moth population.

Federal Agency WPA Projects

The next opportunity for participation in a program for reduction of the brown-tail moth infestation in eastern New England was offered in the summer of 1935 when funds were allocated for this purpose to the Bureau by the Works Progress Administration. Projects were authorized to be operated in each of the six New England States and administration was assigned by this office to Dr. J. N. Summers. Since the most of the supervisory force of this Division was necessarily engaged in supervision of the gypsy moth WPA projects very close cooperation was undertaken with the several States for operation of the brown-tail moth projects. This cooperation was given most heartily and experienced personnel was assigned by the various States for direct supervision of the workers. On the average at least ninety-five percent of the employees were assigned from the National Reemployment Service from relief rolls and the force was gradually built up to a maximum of 1,800 men during the winter of 1935-1936.

The purpose of the projects was of course to cut and destroy as many winter webs as possible, to scout in the surrounding territory to determine the extent of the infestation, and to remove favored and worthless food plants to make the entire area as far as possible less susceptible to reinfestation. Working crews were distributed throughout the infested areas on the basis of preliminary observations made in the summer of 1935 prior to starting the projects. This preliminary survey was made only superficially and while general infestation was noted conditions did not indicate that any great amount of defoliation might be expected. Nevertheless, approximately 4,675,000 webs were cut and destroyed before April 30, 1936 of which 4,000,000 were

gathered in Maine and New Hampshire. No webs were found in Vermont or Connecticut and only a few in Rhode Island. Nearly 400,000 worthless food plant trees were removed throughout the area of which 280,000 were cut down and disposed of in Massachusetts. The large number of winter webs found was rather suprising and undoubtedly this work prevented a rapid increasein brown-tail moth population.

In the fall of 1936 additional funds were provided through the WPA and the projects were resumed with a maximum assignment of 1,360 men reached in February 1937. This year over 3,000,000 winter webs were cut and destroyed, more than half of these in New Hampshire alone. (Plate LVa) Again this year no webs were found in the State of Connecticut and only 3 in Vermont and 44 in Rhode Island. Slightly under 65,000 worthless trees were removed. This latter phase of the work was done as in the previous year mostly before the deciduous leaves fell in the fall and after that period in the spring when it was not practicable to cut webs because the hibernating caterpillars had begun to move about and feed.

Weather conditions during both winters were reasonably favorable although it was necessary at times to confine the work to the ground when icy conditions of the trees made climbing too dangerous. Highly skilled men are not required on brown-tail moth projects except those who are assigned to climb high trees to remove the webs of the insect.

During the period of these WPA projects over 3,160,000 acres were scouted in the fiscal year 1936 and 4,400,000 acres in the fiscal year ending June 30, 1937. Improved employment conditions resulted in reduction of available WPA appropriations and further allocations to this Division for brown-tail moth work were not made so that these

projects were closed on June 30, 1937. At this time large acreages, in some cases embracing several contiguous towns, were found free from the insect particularly in the southern portion of the infested area and it was the consensus of opinion of those most familiar with the work that if thorough and persistent work could have been continued over a short period of years the insect could have been cleared from the infested area which would have meant its extermination from the United States.

During the period since the closing of the CWA and WPA brown-tail moth projects, and as a result of local control work in the States concerned, the intensity of the infestation had not reached, up to 1942, the same severity as was the case when the projects started, and the possibility of spread to new territory has been greatly reduced.

PART XII

Natural Control

Effect of Foreign Parasites and Natural Enemies

Results of parasite work have been cited in many bulletins published since the work began and a summary was issued in 1929 (Technical Bulletin No. 86) which brought the data up to date at the time the laboratory and field work were separated. Reference is made to this work in previous parts of this reports and the bulletins published.

Native American parasites and predators have been collected, studied at the laboratory and observed in the field every since the gypsy moth and the brown-tail moth were first found in the United States. In all cases their influence has been incidental, local and insufficiently important to be considered effective in any way upon the control of either of these insects.

While the introduction of natural enemies from their native homes did not achieve the immediate results envisioned by ardent advocates of control by parasites it is true that several useful species have survived, increased and spread after being colonized in the field and have given helpful aid in reducing both the gypsy moth and the brown-tail moth. They may not have prevented defoliation of trees and spread of the gypsy moth and the brown-tail moth but have at times caused marked reduction of these species in some localities. These results are well worth all the effort and expense involved.

Whether these natural enemies will survive and be as useful in other parts of the United States where the gypsy moth and brown-tail moth might find lodgment, by escape from their present areas of infestation, can be determined only if spread of these pests should occur.

Calosoma sycophanta Linnaeus and Compsilura concinnata Meigen have been recovered in New Jersey and Pennsylvania, indicating their survival under the climatic and host conditions in these States. Both these species have been colonized in Canada as a result of collections made in the New England States by assistants of the Dominion Entomologist and recoveries have been made principally in New Brunswick and Nova Scotia. From 1912 over 10,800 individuals of Calosoma sycophanta, one of the most efficient introduced enemies of the gypsy moth, were shipped to entomologists in Alabama, Arkansas, Colorado, Delaware, District of Columbia, Florida, New Mexico, North Carolina and Washington for colonization. Schedius kuvanae Howard, the egg parasite introduced from Japan and successfully colonized in the southern part of New England, was also colonized in Washington, D. C. and in Illinois at sites of tussock moth outbreaks, in the vicinity of Maxwell, New Mexico after laboratory tests had shown it would attack the eggs of Hemileuca oliviae Ckll. and in large numbers in Spain, Morocco and Algeria in the hope they might be useful in control of the gypsy moth and as a matter of international cooperation.

The gypsy moth parasite work was undoubtedly the most extensive and long sustained large scale effort ever attempted to solve a problem of this type. It brought world wide attention to parasites as agencies for controlling such accidentally introduced insects as the European corn borer, Japanese beetle, scale insects, fruit flies and other insects accidentally introduced into the United States.

The "wilt" disease of the gypsy moth and the brown-tail moth fungus are the most important natural enemies of these pests which

are native to the United States or were already established when the gypsy moth and brown-tail moth were first introduced. These diaeases during some seasons kill enormous numbers of the caterpillars; as a rule most often in heavy infestations. The efficiency of the brown-tail moth fungus depends somewhat upon the weather and is usually of most benefit when moisture conditions are favorable. Insect-eating birds have been recorded as beneficial in reducing the number of gypsy moth and brown-tail moth caterpillars but not sufficient to be considered a controlling factor.

Effect of Temperatures and Air Currents

Mention has been made of the effect of weather upon the gypsy moth and the brown-tail moth with reference to the several publications resulting from experiments and observations in respect to mortality when conditions were unfavorable and to dispersion or increase when they were favorable.

Both pests have become established in New England where severe winters are not uncommon. Exposure to extremely low temperatures of 25 degrees below zero and lower results in killing of gypsy moth eggs and brown-tail moth caterpillars in winter webs. Often these temperatures occur when there is deep snow which covers a large percentage of the egg clusters and the protection afforded nullified the effect of the extreme cold. Clusters deposited above the snow line many times are protected by a covering of ice and will survive the cold. These factors render difficult accurate forecase of winter mortality. In the spring and early warm spell may induce early hatching of gypsy moth egg clusters and then a heavy frost may follow which will kill the small caterpillars or destroy the newly unfolded foliage causing cater-

pillar starvation. Heavy rainfall during the period the caterpillars are in the first larval stage frequently causes heavy mortality. There are records when these circumatances have occurred and reduced or eliminated potentially dangerous infestations.

Severe winter weather has limited also the value of some species of introduced parasites, particularly Schedius kuvanae, whose usefulness has generally been restricted by climate to the southern sections of New England. Others have been greatly reduced during abnormally cold winters and did not reassume their former importance for several years following.

The greatest influence upon spread of both pests has been the wind. Great numbers of brown-tail moths have been carried by strong winds for long distances to previously uninfested territory and reinfestation of areas near heavily infested territory by means of wind has not been uncommon with this strong flying insect.

Spread of the gypsy moth in spite of thorough exterminative treatment remained unexplained until detailed experiments revealed the fact that the young first stage caterpillars were dispersed by the wind over considerable distances when weather conditions were favorable. Temperatures above 65 degrees Farenheit stimulate caterpillar activity and if an infestation is heavy there is constant movement about in search of food. Winds moving at velocities of 8miles per hour are sufficiently strong to remove the small spinning larvae from their support and sudden gusts will dislodge them if they are actively moving about in the higher tree tranches at temperatures below 65 degrees. The possibility of spread of caterpillars and establishment of new colonies at very long distances is remote but local spread by this means is a decid-

ed factor that must be taken into account in any program for control or prevention of spread.

The tremendous far reaching influence of the 1938 hurricane perhaps even yet has not been fully appreciated. The direction of caterpillar wind spread in New England as a rule is to the north or northeast. This reduces the danger of windspread dispersion to the uninfested west and south. The force of the hurricane was directed from the heavily infested areas to the west and the discovery of small, isolated infestations established in and beyond the barrier zone since 1940 must certainly have been the result of hurricane dispersion of whole or broken gypgy moth egg clusters on dislodged twigs, pieces of bark or leaves on which they had been deposited. Fortunately tropical hurricanes very rarely occur in New England.

PART XIII

Artificial Control

Methods of Scouting

Scouting conducted within and to the east of the barrier zone prior to 1929 consisted primarily of the intensive examination of tree growth in residential areas, recreational parks, along roadsides, in open country and along wood edges. The limited amount of woodland scouting undertaken in this region was largely confined to rough cruising in the area of most favored host species on high elevations in territory under suspicion so as to locate and promptly apply control measures in those areas found infested especially where there was danger of wind spread into uninfested territory. Crews assigned to work in residential areas, in open country, etc. average five men but in the rough cruising of suspicious woodland areas only two thoroughly experienced men are normally employed in each crew. The foreman is furnished a large scale map of the township where scouting is to be done for use in planning his work and effectively directing the crew and for recording as accurately as possible the location of all infestations found. He is also supplied with special gummed paper arrows which are posted in front of his residence or boarding house and at all road intersections passed during the work day. On the arrows pointed in the direction taken by the crew, the foreman places his initials, indicates the date and hour of arrival at the intersection and supplies any other information needed to locate the crew with a minimum of effort. Each crew member is equipped with a knife specially designed and constructed for marking rough barked trees and with lumberman's crayon for marking trees with smooth bark, fruit trees and

those growing in residential areas with an individual identifying mark designated by the foreman. This same mark is used by the crew member during his entire period of employment in the crew. These marks consisting of straight line figures and letters such as 7,F,X,L,T,V,11, etc. are approximately two inches in height and when bark knives are used care is taken not to cut through the outer bark.

A hand mirror of special design and construction is furnished each crew member for reflecting light into cavities, under large strips of loose bark out of reach of the scout, in crevices or to look under fence boards and rails so close to the ground that thorough examination of them would not otherwise be possible. Each crew also carries special pint cans of creosote, with handle of brush inserted in the cork stopper, for treating all gypsy moth egg clusters found. Climbing irons and rope are provided and special pole brushes are used in creosoting egg clusters that cannot be reached from the ground with a hand brush. One half pint cans of similar design but with brush attached to the small screw cap and containing white paint are carried by the foreman for marking a suitable tree at the center of each infestation with (1) the last digit of the calendar year the egg clusters were deposited, (2) the number of acres infested, (3) the number of egg clusters found and treated and (4) the number of trees found infested. These figures are placed on the tree one below the other in the order enumerated. The identifying number given to the particular infestation is marked with white paint on an adjacent tree. In order that the district supervisors or others who may be assigned to follow up work may readily locate the infestations white paint arrows are conspicuously placed on trees at convenient intervals between the marked center

of infestation and the nearest point at the roadside. The outside limits of infested woodland areas requiring spraying are outlined with white paint bands with the letter S painted through the band facing the center of infestation so that the foreman detailed to direct the spraying crew may readily determine the periphery of the area to be sprayed even though he did not direct the work of the crew at the time the egg clusters were located.

Forty Foot Strip Scouting

As a considerable number of rather isolated infestations were discovered in the open country throughout the barrier zone from the time of its establishment on July 1, 1923 to July 1, 1929 it seemed quite evident that somewhat similar conditions as to infestation must also exist in the woodland areas where up to that time only a limited amount of work had been done. This matter was given careful consideration and in the fall of 1929 it was concluded that scouting of these wooded areas as rapidly as possible was imperative in order that infestations existing there might be located and treatment applied before there was opportunity for build up and wind spread into uninfested territory. It was realized that because of the extensive territory involved a tree by tree examination would be impractical, therefore, after a thorough study of the problem it was concluded that strip scouting was the only feasible method of securing the needed information. A series of tests were conducted with the scouts deployed in the line at various distances ranging from 10 to 60 feet and after fair trial it was determined that under normal conditions of tree growth and terrain reasonably thorough coverage of the growth in the woodland being scouted could not be obtained with men spaced more than 40 feet apart,

and this distance was adopted as a standard for woodland scouting operations. As the work progressed it was also found that under average woodland conditions a foreman could not satisfactorily direct his crew in a strip totaling more than 400 feet in width, therefore, crews comprising 10 men and a foreman were considered standard for this type of scouting. In scouting woodland areas the foreman studies the general terrain so as to run the strips parallel with rather than up and down the slopes. Taking this factor into consideration the foreman lines his crew up at 40 foot intervals at a convenient point along the woodedge so that work progresses forward with one lineman following close to the edge and the other lineman working approximately abreast at a distance of 400 feet in from the woodedge with the other 8 men evenly spaced between them. On reaching the opening at the other end of the woodland block the men holding their same positions in the line and spaced at 40 foot intervals swing in a semi-circular action around the inside lineman who acts as the pivot. The return strip is then commenced. This method is employed strip by strip and day after day as the scouting progresses. Care is taken to see that the men always retain their same position in the line so that a supervisor familiar with the crew line-up approaching the work from any direction at any point along the line may quickly determine the direction taken by the crew in the last strip scouted and use this information to his advantage in contacting the crew. (Plate LVI)

In scouting by the 40 foot strip method crew members carefully examine and mark all important trees in their direct line of travel and except for stepping out of their line momentarily to closely scout an unusually suspicious tree they examine the growth between

crew members by looking closely for egg clusters from right to left as they move slowly forward along their line. Experience has definitely proven that by this method of scouting trained men locate all infestations of any size and seldom miss single egg clusters that might have been found with a more intensive scout.

Quarter Mile Strip Scouting

Topographic quadrangles have proven very helpful in scouting vast areas of unbroken woodland such as are found in sections of the Green Mountain range and in the Adirondacks. These quadrangles are not only extremely beneficial to the foreman in orienting himself in the woodland area being covered but show in considerable detail the location of trails, streams, swamps, etc. that may be used to full advantage in dividing the territory into smaller units so that the interior sections of the woodland areas that cannot be reached by starting the scout strips at the nearest travelled road may be worked without serious complications.

Topographic quadrangles were also advantageously used in the 1/4 mile strip type scouting conducted in two very extensive woodland areas in the Green Mountain range in the fiscal year 1939. In conducting this work which commenced in the fall of 1938 four thoroughly experienced employees paid from regular appropriation funds were employed. The employee in charge of the crew was furnished with work maps and topographic quadrangles of the towns to be scouted, on which had been drawn numbered lines 1/4 mile in width. With the aid of a compass the foreman, working between two other men each examining 50 foot strips, plotted his course through the woodland so that the

strips of woodland examined corresponded as nearly as possible with the lines on the maps furnished for his guidance. The fourth member of this crew located paths, trails, streams, etc. which could be readily followed in teaching the work sites. He also outlined with paint the town lines within which work was being done and placed on trees along the town line strip-line numbers corresponding to those indicated on the maps. A figure to represent the fiscal year in which the work was done was painted directly under the strip-line number so that if later scouting of these towns by this method was undertaken the course of such scouting might be laid approximately midway between the strips covered in the original 1/4 mile strip scout. Although this method of scouting was very inexpensive as compared with any other method of scouting previously employed it can only be considered practicable in limited relatively inaccessible areas where a very high percentage of the growth is unfavorable for the establishment and development of infestation. Under such conditions it would have value in determining whether or not relatively heavy infestation existed in small pockets of highly favored host species present in the area.

Special Survey

Special surveys such as those conducted west of the Hudson River in the State of New York during the fiscal years 1935,1936 and 1937 may also be conducted at extremely low cost but are valuable only in locating well established infestations. In surveys of that nature experienced men are also needed as the success or failure of the undertaking, to a very large extent, depends on the ability of the employees

detailed to such work to select for examination the localities most likely to be infested. In general these men working in pairs examined trees, shrubs, etc. in railroad freight yards near sidings, and depots, around hotels, prominent tourist homes and garages, in cemeteries, on large estates where considerable planting had been done and in areas where road machinery had been stored during recent road construction operations. The fact that no infestation was found in New York or in the other States previously referred to where this type of work was done strengthens the belief that aside from the isolated infestation located in northeastern Pennsylvania no serious infestation now exists. beyond the area of contiguous infestation which is confined to the New England States and eastern New York.

Use of Assembling Cages

During the State work experiments were begun in 1893 to determine the means by which male gypsy moths were attracted to the females as this had a definite bearing on the fertility of the eggs which were deposited. The principal object at that time was to determine whether a sufficient number of males could be destroyed to limit the reproduction of the species in the field. The results indicated that this could not be done.

Within the next few years further experiments were conducted to determine the distance to which males could be attracted by the females. These tests wer carried on by confining freshly emerged females in cages and releasing marked males at different distances. It was determined that such attraction might occur under favorable conditions for at least a mile as the result of experiments carried on by the writer and

others in treeless areas where similar type of cages were used.

In 1913 Mr. C. W. Collins was assigned to continue this work with the idea that further information might lead to results which would make possible the development of a method for determining new points of infestation which would be less expensive than intensive scouting. These experiments were carried on for a period of years and some encouraging results were secured which have been recorded in Technical Bulletin No. 336 of the United States Department of Agriculture by C. W. Collins and S. F. Potts, published in December 1932.

During the progress of this work it developed that attraction primarily due to the scent of the females was recognized by the males under favorable weather conditions and extracts were made of the tips of the abdomen of the female using benzol or xylol as solvents. This material on cotton batting was placed in a small tin box which was inverted and attached with a nail to a tree to which was applied a coating of tanglefoot. (Plate LXIX) A modified cone-shaped cage made of heavy oiled card-stock paper similarly attached has been used since 1942. (Plate LXIXa) It was sometimes possible to catch males by using this method in locations where little or no infestation was known to exist. In order to determine exact location of colonies, thorough manual scouting had to be done surrounding the cages. This method did not always lead to the discovery of new colonies even in cases where the territory surrounding the cages where males were caught was thoroughly examined. Furthermore, in some cases new fertilized egg clusters were sometimes found near the cages where no males were caught, which threw some doubt on the realiability of this method. In order to obviate the necessity of live females being placed in the cages extracts were used in the terri-

tory outside the known infested area so that no danger of bringing about the establishment of new colonies in new territory could result. Special experiments were carried on by Dr. W. R. Bloor of the Harvard Medical School in cooperation with the gypsy moth laboratory in 1917, and later by Dr. C. H. Fiske, a biological chemist of that institution and Mr. B. L. Souther, organic chemist working under the direction of Dr. E. P. Kohler of Harvard University, to determine if possible whether an attractant material could be prepared synthetically. This would make possible the production of material in large quantities which could be readily placed in cages over wide areas and eliminate the great expense of collecting live material for preparation of extracts which requires a large amount of labor and is attended by a high percentage of mortality which reduces the output very materially.

These experiments did not solve the problem of producing a synthetic product but some improvements in making up the extracts from live material resulted. Although the extracts were not as satisfactory or reliable as might be desirable and did not produce data which was as satisfactory as careful scouting it was determined to carry on this work in the field in a relatively small way on account of the expense and the shortage of skilled men to collect, handle and check up the results in areas in or near the barrier zone and in suspected localities in New Jersey where every method was being used as intensively as possible to bring about the extermination of the insect. The use of cages supplemented by scouting resulted in some new infestations being found. This method has been continued in Pennsylvania and in sections of New York as well as in New Jersey annually since 1932 and has formed a valuable accessory to the scouting work which has been carried on each year.

In the spring of 1942 Dr. Annand, Chief of the Bureau, became interested in this phase of the work and arranged for special investigations to be carried on by the Division of Insecticides of the Bureau and this plan of work has been developed by that Division in cooperation with the Division of Forest Insects and the Division of Gypsy Moth and Brown-Tail Control, and new information has been secured which it is hoped will extend the usefulness of this method.

Methods of Spraying with Ground Equipment

Spraying of Infested Woodland Areas

Factual data concerning the evolution of spraying apparatus from the crudely designed hand operated barrel type equipment, used by the State of Massachusetts gypsy moth organization prior to 1900, to the most modern high powered sprayer units capable of developing and maintaining working pressures up to 1,500 pounds per square inch designed and constructed primarily to meet the unusual requirements for spraying woodland areas infested by the gypsy moth remote from usable roads are furnished in some detail elsewhere in this report. Mention has been made also of improvements in the 1" spray hose, the quick-hitch couplings, and the developments in spray nozzles from the mist to the so--called solid stream type used in spraying high growth, but in order to complete the picture of this very important method of gypsy moth eradication and control work it seems advisable to briefly describe present day field methods employed in spraying large areas of infested woodlands where hose lines frequently averaging more than a mile and occasionally two or more miles in length are required.

Few people other than those experienced in large scale spraying operations in infested woodland areas appreciate the careful planning necessary to insure the coverage of the maximum acreage per sprayer unit. To accomplish this objective it is necessary to secure for each infestation to be sprayed detailed information concerning its location in relation to the nearest suitable source of water supply, location of property bounds, total acreage to be sprayed, maximum length of hose line needed to reach the most distant point to be sprayed from the sprayer setup, the most siutable location for the first spray line, and the amount of work needed at the selected site for the sprayer setup so that the apparatus may be set in position a few days before spraying begins and may be operated on approximately level ground while this work is in progress. Sometimes prior to the spraying season, before the sprayer setup and hose lines are placed in position, arrangements are made with each property owner for securing his formal permission to conduct the spraying operations. Hå is requested to visit the site on his property where spraying is planned, the situation and necessity for the work is explained, and an official permit is secured from him indicating that the conditions are mutually understood. If the property to be sprayed is located in or near pasturage where cattle might feed on spray-poisoned foliage precautions are taken to have the cattle pastured elsewhere or have the area fenced off prior to the spraying season. If government owned barbed wire fence is used a fencing permit is secured on which the conditions governing arrangements for its erection and removal are written to avoid misunderstandings which might otherwise arise.

The first hose line, consisting of hose in standard 50 foot lengths, is laid from the sprayer to the farthermost limits of the area to be sprayed,parallel to and about 200 to 250 feet in from one edge of this area, care being taken to allow sufficient slack in the line so that if breakage occurs the damaged length may be removed and the hose line quickly connected by taking up some of this slack. A loop is left at the nozzle end of the hose line which is sufficient length to permit the nozzleman and crew to spray laterally a distance of 200 to 250 feet.

Experience has shown that a nozzle pressure of 300 pounds per square inch is needed in solid stream spraying in order to do the work most effectively regardless of the apperture of the tip in use. In order to arrive at the pump pressure needed to develop and maintain the desired nozzle pressure the operator with full knowledge of the length of the hose line furnished by the crew foreman fills the hose with spray mixture, then disengages the pump and instantly takes a reading of the pressure registered on the pressure gauge for the purpose of determining the weight in pounds of the mixture in the hose line. He then consults the pressure table suitably attached to each sprayer unit and determines the number of pounds pressure needed to overcome friction losses in a hose line of the length being used. To these two figures (weight of solution in hose line and pressure needed to over come friction losses) the operator adds 300 pounds and the resulting total is the working pressure required at the pump to provide the desired pressure at the nozzle. The operator is kept advised by the crew foreman of any reduction or increase in the length of the hose line or in the size of the tip being used so that the needed pump pressure may be constantly maintained.

In solid stream spraying the output varies considerably with the size of the nozzle tip needed to reach the tops of the trees. In order to properly treat growth varying heights each crew is furnished with nozzle tips having apertures of 1/8", 3/16", 1/4" and 5/16" so that the proper size tip may be readily available for use when needed. Under normal conditions the 1/8" tip is used in spraying fruit trees and other growth up to 25 feet in height, and 3/16" tip in growth from 25 to 50 feet, the 1/4" tip from 50 to 75 feet and the 5/16" tip for trees of more than 70 feet in height.

In working out from the main hose line the growth in a strip approximately 25 feet in width is thoroughly sprayed and a similar strip is so treated on the opposite side of this lateral line as the crew returns. This procedure is repeated on the other side of the main hose line. In this way a swath totaling from 400 to 500 feet is treated. The crew continues working first on one side of the main hose line and then on the other, moving closer to the sprayer as the work progresses. When the crew has sprayed backwark a longitudinal distance along the main hose line of from 200 to 250 feet or more, depending upon the nature of the woodland and terrain, the pressure is shut down for five minutes, on the basis of a prearranged schedule worked out with the sprayer operator by the crew foreman, so that all surplus hose may be disconnected and moved laterally 400 to 500 feet to establish a new line. This procedure is repeated again and again until all growth to be sprayed from the first line has been treated. By this means the new line is laid and ready to begin spraying as soon as work along the original line has been finished. The hose is moved in this way in successive steps making it possible to perform continuous spraying with practically no loss of time, except that required

for the crew to walk to the end of the new line to attach the nozzle and resume spraying. Surplus hose removed from the last spray line required in effectively spraying an infestation is carried to the nearest travelled rpad where it is loaded on commercial body trucks for transfer to the site of the next operation if there is additional work to be done or to the place of storage if work is completed for the season. (Plate LVIa)

All spray units owned by this Division are equipped with 300 gallon two compartment tanks and an auxiliary pumper is made part of the equipment so that the empty compartment may be filled by this pumper while the spray mixture in the other compartment is being pumped at the desired pressure through the high pressure pump to the nozzle in treating infested areas. The output of a sprayer operating under normal conditions on the basis of an 8 hour day is approximately 10,000 gallons, although the area which may be treated daily varies greatly depending upon the height and density of the growth. Under average conditions 8 to 10 acres can be treated by each spraying crew in a working day of 8 hours. When sufficient man power is available spraying is performed on the double shift basis of a 6 hour day for each crew so that each sprayer may be continuously operated over a period of 12 hours daily when weather is favorable, which will permit an increased coverage of nearly 50 per cent per day with each spray unit. This is an important and valuable advantage since the length of the spraying season is very limited and obviously the more spraying that can be accomplished per unit per day the greater the acreage that can be covered within the season.

The spraying crew consists of a foreman, pump operator, nozzle-man and 8 to 10 men who handle the hose line. While the foreman is

directly responsible for all the work of his crew much of the success in accomplishing complete and economical coverage of the foliage will depend on the ability of the nozzleman. On some crews the job of handling the nozzle will be alternated between two or more men in order to maintain within the crew more than one experienced nozzleman. The pump operator, if fully experienced and alert, by prompt and careful attention to the spray pump, tank supply and mixture, will aid very materially in insuring a maximum acreage coverage by reducing lost time on account of shutdowns and mechanical failures.

Spraying of Infested Residential Areas

Although spraying by this Division is largely confined to the treatment of infested woodland areas it frequently becomes necessary to use solid stream spraying in the eradication of infestations discovered in residential areas. In recent years such work has been confined primarily to the treatment of infestations found in several of the communities in the Lackawanna and Susquehanna River Valleys in Pennsylvania. In addition to the problem of securing permits from property owners or tennants well in advance of the time spraying begins it is necessary to delegate one of the crew members to go from house to house immediately before spraying of each infested property is undertaken for the purpose of notifying the owner or tennant to remove clothes from lines and arrange for the covering of berry patches and leafy vegetables such as lettuce while the crew is spraying the infested property. Although the hose lines are short, approximately the same number of men is required as in woodland spraying because of the necessity of extreme care in handling the hose line while working around flower beds, vegetable gardens, etc. Im-

mediately upon completion of the spraying of each property a second crew consisting of 4 to 5 men including the nozzleman thoroughly spray with clean water supplied by another spray unit the buildings or sections of buildings, fences, etc. hit by the spray solution so that it may be washed off before it has an opportunity to dry. If this procedure is not followed many claims for damages due to stains caused by the spray mixture may result. In spraying trees in cemeteries it is sometimes necessary to wash some of the monuments and headstones by hand with a sponge after they have been washed by hose with clear water under pressure because of the tendency of the spray solution to adhere to the porous surfact of some stones.

Although this method of treating infested residential properties is rather expensive because of the additional apparatus and men required it is very effective as a means of promptly eradicating infestations in residential areas where there is always considerable hazard of spread to uninfested territory. The expense of using high pressure apparatus for treating residential property, even though it requires use of a second unit for washing off buildings, is offset perhaps by the fact that the trees, particularly the taller and heavier foliaged trees, are more thoroughly covered and thus a more nearly perfect control job is accomplished than is possible with smaller apparatus of less power.

The high pressure spraying apparatus used in recent years on gypsy moth work was designed as mentioned before primarily to meet the peculiar problems presented in treating infested woodland an difficult terrain. Nevertheless, although not part of the present day Federal control program, roadside spraying with this equipment is

entirely feasible and no doubt because of the high pressures and volume of output it is capable of delivering, the efficiency of the equipment is fully as great as that of apparatus in general use for this purpose.

Silvicultural Thinning

Reference was made earlier in this report to the intensive methods used for controlling and exterminating the gypsy moth and emphasis was placed on the care that was necessary in order to accomplish this purpose. A part of this work involved the removal of badly infested trees but in residential areas every effort was made to apply other treatment than cutting in order to protect shade trees. Under these conditions it was frequently necessary to remove dead or dying branches and seal cavities as these were favorite places for the moths to deposit their eggs. Many of the workmen acquired great skill in carrying on this work and after the State work in Massachusetts was discontinued in 1900 they sought contracts from private individuals to take care of valuable shade trees. In connection with pruning it was necessary to climb trees and during the early part of the work the use of ladders was supplemented by using spurs to climb to the higher parts of the trees. In later years the method of climbing with ropes was substituted.

During the early years of the gypsy moth work little attention was paid to the care of trees with the exception of pruning and thinning work which was done in orchards, but the progress that was made in this line of work for gypsy moth control was one of the impulses from which was developed specialized work of this kind and made a definite contribution to the development of arboriculture as it is now practiced.

For many years when trees were completely removed on this project they were severed at the ground level which eliminated loose bark or cavities under which egg clusters might be deposited if high stumps were left. After the Federal work began in 1906 large areas of badly infested woodland along roadsides were treated to destroy the gypsy moth and care was always taken to remove the least valuable and those species for which the insect showed preference so far as food was concerned. This practice made future care of the trees on roadsides less difficult and reduced the future cost of operating. In large woodland areas where colonies of the insect existed more drastic measures were frequently necessary in order to clean up the colonies in the shortest possible time. After more knowledge had been secured relative to the major food preferences of the insect the amount of cutting of non-favored species was greatly reduced. In 1913 when the Federal control work was confined to the outside border of the infested area the woodland type of operations was more frequently employed as colonies of the insect were found in such situations.

During the period when Mr. F. W. Rane was State Forester in Massachusetts he vigorously advocated the practice of logging, supplemented by planting if necessary, as the proper procedure for gypsy moth control on the premise that the material cut could be sold at a sufficient price to meet the cost of the operation, thereby improving the forest and giving permanent relief from this pest. As many owners as possible were induced to carry on these operations at their own expense under supervision of trained foresters. The cost of the operation left a very small margin between profit and loss and as the market for lumber and cordwood was very unstable only a limited number of

owners carried on operations of this sort. This did not materially decrease the building up of infestations or the spread of the pest in the infested territory as a whole. After 1920 when he retired from office this plan was modified and it was left to the individual to carry on these operations.

After the barrier zone was established in 1923 it was necessary for the States to assume the supervision of the territory east of the barrier zone line. Federal work was concentrated in the zone with the addition of course of the completion of the gypsy moth extermination project in New Jersey, similar work in a vigorous infestation found in 1932 in Northeastern Pennsylvania and minor colonies west of the zone which were found from time to time and were given exterminative treatment.

In 1928 the research work was transferred to the Division of Forest Insects and in 1934 after the quarantine enforcement was transferred to Mr. L. H. Worthley, in charge of the European Corn Borer-Japanese Beetle Control Projects of the Bureau, the gypsy moth and brown-tail moth control Division continued exclusively the scouting, clean up and extermination and treatment work for the purpose of preventing spread of the insect. About 1930 the idea of applying silvicultural methods for controlling the gypsy moth was strongly advocated by some foresters and this was given considerable impetus through the establishment of gypsy moth work under the direction of this Division in CCC camps in the territory between the barrier zone and the Connecticut River. Some enthusiasts believed that this method would practically solve the woodland problem so far as gypsy moth is concerned and a few thought it should be practices in the barrier zone

and in Pennsylvania.

A bulletin was issued in August 1936 by the Massachusetts Forest and Park Association, Boston, Massachusetts titled "Silvicultural Control of the Gypsy Moth" by C. Edward Behre, Northeastern Forest Experiment Station, A. C. Cline, Harvard Forest, and W. L. Baker, United States Bureau of Entomology and Plant Quarantine. It offered the thesis that in woodlands silvicultural control practices were the most economical means for dealing with the gypsy moth, serving the double purpose of control and forest stand improvement. The authors proposed plans for treatment of the different forest types existing in the infested territory admitting, nevertheless, that artificial control methods, spraying and creosoting egg clusters "are indispensable for checking incipient outbreaks within the Barrier Zone." Difficulties arose in putting this method into operation due to the fact that a large percentage of the woodland was occupied by species which were favored food for the insect and that it could not be employed with the object in view of exterminating the colonies, which practice was necessary if the barrier zone was to protect the rest of the country from infestation. There seemed to be no Federal, State or public agency which had the funds to carry on this type of operation on private property in order to treat large acreages of woodlands. During the operation of the CCC camps, however, where the gypsy moth work was supervised by this Division, very considerable acreages were thinned so as to remove as large a percentage of favored trees as possible but in most cases this work was supplemented particularly in heavy infestations by treating the egg clusters and destroying all caterpillars that massed under the burlap bands.

In 1936 opportunity seemed to be present for testing the feasibility of the proposed silvicultural control practices and, in cooperation with the Northeastern Forest Experiment Station, several plots were established in the infested areas east of the barrier zone where the CCC camps were operating under the gypsy moth project of this office, the thinning and other work being carried on by camp enrollees and the supervision of the plan for the thinning operations being directed by the Northeastern Forest Experiment Station. Obviously this work required the lapse of many years before definite conclusions could be reached and when Station funds became unavailable for this work and when CCC enrollees could not be supplied to perform the labor it had to be discontinued.

One of the difficulties in carrying on thinning work has been the large number of woodland areas with small acreages owned by individuals where the growth is of mixed species of different sizes, much of which is favored food. The difference of opinion among various foresters as to the selection of trees for elimination also complicated the problem.

In a great many cases it was impossible to eliminate the favored food plants and benefit the forests without supplementing this work by planting resistant species and this Division had neither the authority for planting nor the funds that were necessary to operate on this basis. Only a very limited number of owners could be interested in meeting the cost of planting because of the expense involved and the low value of the land. Our primary obligation was to destroy the gypsy moth wherever found and as rapidly as possible in order to prevent the spread of the pest and to endeavor to do this in a way which would cause as

little damage as possible to the property.

Federal work was continued on the basis of extermination and cleaning up gypsy moth colonies. When these occurred in woodlands every effort was made to eliminate favored food trees when this could be done without severe detriment to the stand. In many cases this work had to be supplemented by spraying in order to rapidly eliminate the colonies. Large acreages in the barrier zone in New England were treated in this way, and in New York State under the direction of the State Conservation Department substantial acreages were handled in the same manner in that section of the barrier zone, particularly in Putnam County, and as well as in a large isolated colony west of the zone in Shawangunk and in small areas in Ulster County.

These thinning operations improved the stands and combined with the usual treatment measures including spraying eliminated the infestations in most of the area. Similar treatment of large areas was also carried on in Pennsylvania with excellent results.

In order to arouse additional interest in thinning work and the elimination of favored food trees a conference was held in March 1940 with Mr. G. H. Wirt, Chief Forest Fire Warden of the Pennsylvania Department of Forests and WAters, with the view of securing cooperation with his office looking toward the development of plans to induce owners of infested woodland property to practice replanting of non-favored trees in areas where selective thinning or clear cutting had to be done to eliminate the gypsy moth. Mr. Wirt instructed his foresters to cooperate along these lines and to interest property owners whenever possible as to the kind of planting that should be done and to give them information as to probable costs and how to procure suitable varieties

of seedlings and transplants for this purpose. A number of contacts were made with owners but only a limited number became sufficiently interested, principally on account of cost, to take up this work. The Pennsylvania Game Commission was interested however and in 1941 replanted eight locations under it s control in Clifton, Collbaugh and Lehigh townships, using 75,000 coniferous seedlings in these operations.

Other Methods Employed for Control and Eradication of the Gypsy Moth

Employment of unskilled labor is often warranted to creosote egg clusters at colony sites where there is an intensity of infestation and skilled scouting methods are not necessary to discover the clusters. The crews are deployed in a manner similar to a scouting line and all growth is carefully examined so that every egg cluster may be destroyed by the application of the creosote. These workers confine their efforts to the creosoting of egg clusters which can be reached from the ground with brushes held in the hand or attached to bamboo poles. One or more climbers are included with or follow the crew to reach and destroy clusters which have been deposited higher in the trees.

It is the usual practice also when this rough creosoting operation is undertaken to gather up, pile and burn debris on the ground which might harbor egg clusters. It is sometimes more practical also to remove and burn standing dead trees rather than to attempt creosoting egg clusters which may be hidden in cavities and beneath loose bark. As a matter of record and as an indication of the thoroughness of the work the number of egg clusters on debris is estimated as well as those creosoted on the standing growth.

Very often an infestation will be concentrated in or near stone-walls which must be thoroughly and carefully treated. Sometimes these walls are so situated that removal, examination, treatment of egg clusters, and replacement of the stone is not possible or feasible. In such instances a burning apparatus is used which is similar in construction and operation to the "cyclone burner" used on the Massachusetts work during the 1890's.

All the types of work described above are supplemental to treatment work undertaken in the usual course of scouting and are types on which unskilled laborers may be employed most advantageously. They are tasks very essential to a complete job of eradication when the intensity of infestation is sufficiently great to require concentrated attention particularly if the colony site is located in forest littered woodland.

Another important method already described and which has remained in use since the earlier days of gypsy moth work is the practice of tree banding for destruction of gypsy moth caterpillars. This method is used when spraying is not practicable or impossible and is a job on which unskilled labor can be employed with good results.

In many instances a combination of two or several of these methods is employed for eradication or reduction of infestations. Sometimes it is most economical to confine operations at a colony site to spraying, in other cases a rough creosoting job followed by banding of the trees will be the most feasible, or silvicultural thinning of an area in which spraying may be planned will be undertaken. Effort is always made to utilize the most effective means at the lowest possible cost and this will generally depend on the conditions which exist at each particular site of infestation.

PART XIV

Improvement in Equipment

Spraying Equipment

Many different types of spray machines were in use by the towns, cities, State commissions and private individuals when the Federal gypsy moth and brown-tail moth control work began in 1906. Most of those which were used or developed during the work in Massachusetts prior to 1900 were small low pressure pumps operated by hand power. There were only a few power outfits driven by gasoline motors and they were equipped for mist spraying, necessitating climbing of the larger trees to secure full coverage of the foliage.

Solid stream spraying was first started by Mr. J. A. Pettigrew in 1895 while he was superintendent of Prospect Park in Brooklyn, New York. For this purpose Mr. Pettigrew assembled a sprayer with a steam engine as its power source and this was used in the Boston Park system. (Plate LVII) Gen. S. C. Lawrence in 1905, at his own expense, purchased and tested a solid stream sprayer assembled for him by a Boston firm which was powered with a high powered gasoline motor. These machines were very heavy and cumbersome and the pumps delivered only 25 gallons per minute at 200 to 250 pounds pressure.

After the Federal work started machines of the latter type were purchases with wooden U-shaped tanks holding between 500 and 600 gallons of spray mixture and powered with a stationary type of gasoline motor. Mr. Rogers, in charge of field work at that time, urged upon manufacturers the desirability of designing lighter equipment with greater pump capacity, and after consultations special pumps were made available and 4-cylinder two-cycle marine motors were used. In

1909 improved spraying machines were operated on the Federal work, having a capacity of 35 gallons per minute at 350 pounds pressure but the outfits weighed about 4,000 pounds. On these machines, used almost entirely for roadside spraying, Mr. Rogers placed a "water tower." This was set on top of the tank, mounted on a 6-1/2 foot mast to which was attached a 20 foot tube by a swivel arrangement so that the tube could be pointed in any desired direction. On one end of the tube the nozzle was attached, on the other the hose was coupled carrying the spray mixture. (Plate LVIIa) This eliminated the necessity for men to lay and move hose, resulted in more economical operation, and enabled each spraying crew while the sprayer was in motion to treat more roadside mileage than had been possible previously. The efficiency of the tower was somewhat increased by adding a hose line, the nozzle of which was directed by hand from the top of the tank, for treatment of trees and shrubbery close to the road, while the stream from the tower covered the taller, more remote trees. The tower was, of course, useful only for roadside spraying and the usual method of laying hose was necessary for treatment of areas away from the roadsides.

In 1908 Mr. Rogers entertained an idea for spreading dry arsenate of lead onto the foliage in woodlands by means of a bomb containing poison which was shattered above the trees by means of a time fuse. This was taken up with a local manufacturer of fireworks who made up a trial device from Mr. Rogers' idea. The device which was a bomb fired from a small mortar was tried out in September but did not result in an even dispersion or adhesion of the poison.

The following year Mr. Rogers considered the possibility of using a steam ejector or atomizer instead of gasoline motor power. This apparently had the advantages of light weight, low initial cost and less expenditure for upkeep. Authority was secured for purchase of a steam atomizing machine in October 1909 but after further discussion with the manufacturer who proposed to build it the idea was discarded as not entirely practicable.

After carefully checking the performance of the machines in operation in 1909 with Mr. L. H. Worthley, then acting in charge of the State moth work, Mr. Rogers and with Mr. Pettigrew, then in charge of the Boston city parks, it was agreed that a sprayer of less weight, greater capacity, more dependable engine and simpler pump would be needed if the solid stream spraying method was to be continued. An improved machine was developed by using a very light phosphor bronze pump powered with a 4-cylinder four-cycle motor mounted on a specially constructed horse drawn running gear. This machine was rated to deliver 33 gallons per minute at 350 pounds pump pressure and by stepping up the gear ratio it delivered 45 gallons per minute at the same pressure. Later in the year 1910 many refinements were made including a slow paddle type agitator suggested by Mr. Rogers for keeping the arsenate of lead and water well mixed in the tank.

The so-called Worthley nozzle was developed about this time based on well known theories about the action of water passing through hose lines under pressure. This nozzle with minor refinements and adaptations has remainded in successful use over a period of 33 years for high pressure solid stream spraying. It overcame the difficulties experienced with the old fire nozzle type and eliminated the necessity for climbing except in exceptionally tall trees. (Plate LVIII)

During this same period a hose coupling was put on the market which had a full waterway and was easy to install and hitch up. It was used on the Federal spraying work. Later further improvements were made and this has resulted in the present day quick-hitch couplings with a double lug which does not leak under high or low pressures and which is sufficiently rugges to stand up under rough usage. (Plate LVIII)

In 1911 the North Shore Improvement Society and the Massachusetts State Forester's office jointly financed the construction of a motor truck sprayer which was effectively used in treating shade and woodland trees. Later additional machines of this type were built for the State Forester's office. In 1916 a motor truck sprayer was purchased by the Federal gypsy moth project which was more satisfactory then the horse drawn machines then in operation. More efficient sprayers were secured each time additional purchases were made, most of the improvements resulting from experience gained by operation and by suggestions of the mechanics and field men, and better performance and more economical operation resulted.

Details of the early developments in spraying machinery and equipment are given in the United States Department of Agriculture Bulletin No. 480, June 30, 1917, by Mr. L. H. Worthley, titled "Solid-Stream Spraying Against the Gipsy Moth and the Brown-Tail Moth in New England."

Demountable power take-offs were invented by employees of this Division which contributed to increased efficiency and reduced operation costs. These inventions were patented as public patents, the first was secured on attachments for the Ford Model T equipment on March 15, 1927. (Plate XLV) When the Ford Motor Company discontinued

this model modifications were worked out for the Ford Model AA truck and were successfully operated during the spraying season of 1929. These units were much lighter than the older models, delivered as great pressure at the pumps and could be driven to spraying sites it was impossible to reach with the heavier outfits. (Plate LIX) A highly improved demountable take-off was patented on February 7, 1933 under the names of Messrs. A. F. Burgess, H. L. Blaisdell and W. H. Campbell.

A large fleet of motor sprayers which were originally purchased in 1927 for use in spraying oil for burning on the Federal Corn Borer Control project were transferred to this Division in 1931. These were altered so as to step up the working pump pressures from 750 to 1,000 pounds, and the tanks were divided into two compartments so that while one compartment was emptied by spraying the other could be filled and the spray material mixed: (Plate LIXa)

In recent years machines which develop working pressures up to 1,500 pounds have been necessary for treating remote areas in woodlands. Hose lines over 12,000 feet in length frequently have been used. Occasionally there are locations where it is not possible to set the sprayer close enough to the water supply for direct suction draft. In such cases auxiliary pumps of the portable type which deliver up to 35 gallons a minute are used to fill the spray tanks.

The units capable of delivering 1,500 pounds working pressure were purchased in 1936 and 1937. Self-powered spray units of 1,000 pounds working pressure were built in 1938 and 1939 which can be placed on any 1-1/2 ton truck chassis. (PlateLX) All these machines were equipped by placing gauges, valves, running parts, etc. in such easily accessible positions that they may be operated by one man. Although complicated mechanisms in appearance these later pumps are actually so

simplified and so rugged that highly trained mechanics are not required for their operation. Occasionally of course there are breakdowns in the field but it is the practice to have travelling mechanics visit each spraying setup periodically during the season to check on the machines and thus the loss of time in this respect is greatly minimized.

Improvements in spraying hose kept pace with that achieved in the spraying machinery. As pump pressures have gradually risen to the present day capacity of 1,500 pounds manufacturers have been able to furnish hose capable of withstanding the enormous strain and rough handling which unavoidably must be contended with in the field.

The present day spraying equipment, hose, couplings, nozzles, pumps and attachments are so far superior to the equipment in use during the first years of gypsy moth work as to almost defy comparison. Although written in 1922 the words of Dr. Howard, "I consider the development of the spraying machinery for hilly woodlands by your force one of the remances of the development of insect warfare," might well have been written today with equal application. (Plate LXa) Great credit is due to the field men and mechanics for originating ideas and suggestions which they have made as a result of operating the different types of spraying equipment on actual field work. This has made possible the rapid progress in increasing the efficiency of the spraying work and is largely responsible for the excellent results that have been secured in treating gypsy moth infestations, many of which were remote from the water supply or in rough woodland areas in which it was difficult to operate.

Aerial Application of Insecticides

The application of insecticides by means of airplane or airships was probably investigated, at least theoretically, almost as soon as

these machines became practical for flying. No doubt more than several investigators were thinking along these lines as early as 1912 but not until after the First World War when airplanes had reached a better stage of practicability were definite attempts made to utilize them for insecticidal control.

Perhaps the first practical application in the United States was made in 1921 when an infestation of the Catalpa sphinx was treated with arsenate of lead dusted from an airplane near Dayton, Ohio. This work was in the nature of an experiment and was reported by Prof. J. S. Houser at the 1921 meeting of the American Association of Economic Entomology. His report was made in a paper, the senior author of which was Mr. C. R. Neillie of the Cleveland, Ohio Park Department, published in the National Geographic Magazine for March 1922. The work was done under the sponsorship of the Ohio State Agricultural Experiment Station, using an airplane and hopper furnished by the Air Service of the United States Army and operated by the later famous Lt. John A. Macready. This hopper which was designed by Army engineers was attached to the side of the plane and operated by hand. Professor Houser reported exceptional success and almost 100 per cent killing of the insect as the result of this experiment.

Later in the winter Prof. W. C. O'Kane, in charge of the gypsy moth work for the State of New Hampshire, became interested in the possibility of treating forested areas infested by the gypsy moth and suggested that an experiment should be conducted to test its feasibility in New England. In the early spring of 1922 definite plans were made to undertake a cooperative experiment by the Gypsy Moth Division of the Bureau with the New Hampshire gypsy moth organization and ar-

rangements were made for this Division to secure an airplane from the United States Army Air Service, to lay out the experiment and for the State of New Hampshire to furnish the necessary materials and other assistance. There was this year evidence that large areas of woodland were heavily infested with danger of extensive defoliation in the vicinity of Lake Winnepesaukee, New Hampshire and it was Professor O'Kane's desire to reduce this infestation if possible. Ground spraying appeared to be rather too expensive and it was hoped that airplane dusting might be possible at less expense. Since very little was known about the efficacy of airplane spraying over large wooded areas it was decided to restrict the experiment to large selected plots. They were laid out, approximately 100 acres each, one in Hookset and one in Alton, with check plots nearby and it was arranged for an Army biplane, Curtiss J N 6, 180 HP motor, to be based at Concord, New Hampshire at the State Camp Grounds. Through the kindness of Professor Houser the hopper used in the Ohio experiment was loaned to the Bureau. After several disappointing delays the first dusting was applied on the plots on June 26, 1922. Arsenate of lead in dust form was used without filler or adhesive and immediately there was considerable difficulty in securing satisfactory adhesion of the dust to the foliage. There was also considerable difficulty in thoroughly covering plots on account of drifting of the material. The hopper proved to be rather unsatisfactory as it did not dispense the dust evenly. It was not demonstrated that an airplane was the best means of dusting from the air or that the dusting material was the most suitable for obtaining gypsy moth control. (Plate LXI)

The following year it was decided to experiment with dusting from a blimp or motorized balloon, since it was believed that the slower speed of this type of ship would allow for better distribution of the insecticide. It was recognized of course that greater emphasis should be placed on the development of a suitable hopper from which material could be dispensed. After several discussion with the Army Lighter Than Air Service as to the advisability of using such equipment for dusting arrangements were completed during the winter for the assignment of an Army blimp. Mr. D. W. Barnes of the gypsy moth laboratory technical staff was assigned to make the experiments. Innumerable delays and difficulties were experienced not only in developing a properly designed hopper in cooperation with the Army engineers but also in fitting the hopper to the cabin of the blimp and adjusting the weight of the hopper and load so that best results could be expected. The hopper was designed to carry 250 pounds of arsenate of lead. There were also several faults in the blimp itself which were overcome only after some delay so that the first trial was not made until July 1923. (Plate LXIa) The blimp was flown by Army personnel from its base at Dayton, Ohio to a prearranged landing field at Henniker, New Hampshire. (Plate LXIb) It was planned to treat two selected areas at Hillsboro and Deering in that State. Only Two flights were made when dust was distributed as leakage developed in the fabric of the balloon possibly due to unusual strain brought on by the extremely bumpy flying conditions and the pilot was forced to decend and the crew dismantled the ship. The trial of the hopper was not of sufficient length to prove its worth and the coverage of the foliage was very poor. Further attempts to experiment with the blimp

type of airship were started the following season but when the proper type of ship did not become available the experiments were discontinued.

During the next few years the use of airplane dusting progressed rapidly in the South under the direction of Mr. B. R. Coad. (United States Department of Agriculture Department Bulletin No. 1204, January 1924, "Dusting Cotton from Airplanes" by B. R. Coad and G. L. McNeil). Arsenate of lime was used successfully on cotton and numerous contractors began carrying on treatment work mostly in the southern States. On account of these developments, particularly on changes in the distributing equipment, which eliminated the necessity ofhaving an assistant in the plane to operate the hopper which reduced cost of personnel and made possible the carriage of a greater load of insecticide, airplane dusting experiments were resumed on the gypsy moth project.

In 1926 a contract was made with the Curtiss Flying Service for continuation of experiments with airplane dusting. During the latter part of June in that year plots were laid out in Sandwich, Falmouth and Barnstable, Massachusetts and a series of tests were made over several days using arsenate of lead. Unfortunately the weather was very rainy, foggy or high winds prevailed. The results were better than those attained heretofore but the cost of application was far greater than ground spraying. A report was published by Barnes and Potts in the Journal of Economic Entomology in February 1927, page 213.

Experiments were continued during the spraying season of 1927 and another biplane was secured for this work on a contract basis. Spraying was done in the towns of Mattapoiset, Freetown and Berkley, Massachusetts where rather heavy infestations occurred. In addition to us-

ing arsenate of lead powder a limited area was treated with a mixture of dry arsenate of lead and fish oil, the latter being mixed with the lead so as to make it adhere to the foliage. These tests were not entirely satisfactory as the oil tended to coat the arsenate of lead in such a way that when distributed on the foliage it adhered in pellets rather than as a fine even coating of minute particles and in some cases there were globules of considerable size which, owing to uneven coating, rolled from the leaves. The distribution of the arsenate of lead without oil was somewhat more satisfactory then had been the case in previous years and this was particularly true if the material was applied when the foliage was moist.

In connection with mixing fish oil with arsenate of lead it developed that when mixed only a few hours before application the material heated to a considerable extent so that there was great danger of spontaneous combustion and that it could only be used with any degree of safety immediately after the materials had been freshly mixed. It was evident that there were many problems to solve before airplane spraying in forests could be used effectively for gypsy moth work at a reasonable expense.

In cooperation with the Forest Insect Laboratory of the Bureau further experiments were undertaken in 1936 for insecticidal control from the air by using an autogiro. This type of heavier than air machine was believed to have greater promise than other types because it was capable of slow controlled flight which is a characteristic not possessed by the fixed wing airplane. The autogiro was procured on contract by the gypsy moth control Division which also furnished the insecticides required. A new type of distributor was used and

the arsenate of lead was mixed with fish oil and water and applied as a wet spray under the direction of Mr. Potts and his associates and reported in the Journal of Economic Entomology, June 1939, volume 32, number 3, page 381. Plots were treated in Freetown, Massachusetts. The results were encouraging and more satisfactory than had been secured heretofore by treatment from the air. The distribution of the spray was uneven, however, and the material had a tendency to be deposited in flattened globules rather than by a fine even coverage. The over-all cost exceeded the expenditure that would be necessary to apply similar treatment on the same type of woodland and terrain by ground sprayers.

Cooperation had existed for several years between this Division and the Division of Control Investigations in the Bureau and as Mr. A. G. Galloway had from time to time been detailed to give engineering advice and work out technical problems in connection with spraying apparatus owned by this project it was arranged with Dr. Lon A. Hawkins, Chief of that Division, who was interested in any mechanical improvements that could be made within the Bureau, to have him work on this problem. Mr. Galloway's salary was paid from his own Division and the gypsy moth Division furnished shop facilities, use of equipment, mechanics to assist in the work and what supplies were necessary, It became apparent during the winter that a type of equipment which would carry arsenate of lead and fish oil in separate chambers could be designed so that the fish oil would be atomized and the lead blended with it as the machine was moving through the air. This would make it possible to dispense with the carriage of water and thereby increase the load of useful spray material so that a larger acreage could be sprayed

than with the equipment and material which was in a water mixture. Considerable mechanical work was necessary and many preliminary tests were made on a small scale under controlled conditions in a specially equipped room at the Greenfield storehouse so as to learn by trial the practicability of a distributor built along these lines.

In August 1937 a dummy set up was made and was mounted on a 1-1/2 ton truck which was driven rapidly on a smooth wooded road in order to determine whether the equipment had merit or how it could be improved. As a preliminary test the results were reasonably satisfactory but the next step was to build the equipment and install and use it on a plane. Owing to a long sickness of Mr. Galloway this work was somewhat delayed so that the device was not ready for air testing before the spraying season began in June 1938. In the meantime arrangements were made in cooperation with the Forest Insects Division to treat with the previously used equipment about 200 acres of infested tree growth in the Wendell Forest near Greenfield. This Division contributed the rental of the plane for the season, spraying material and the survey and recording of data relative to the condition of the plots. The Forest Insects Division secured and interpreted the technical data. The results were fairly good but the distribution of the poison did not equal the standard that was usually set for gypsy moth spraying from the ground and the cost per acre averaged higher than ground spraying. Unsuitable weather for flying hindered the work so that 12 days were required to do the job which under good conditions could have been accomplished in 4 days.

In the meantime an autogiro was purchases by this Division and in August the equipment was in shape so that it was installed and operated from the autogiro for testing purposes during the late summer. The results were so satisfactory that in June 1939 a field test was made in Deerfield, Massachusetts covering 200 acres of woodland area treated with the new equipment. The Forest Insects Division cooperated on this work. The results seemed to be sufficiently satisfactory so that after minor changes and adjustments this machine could be used in the barrier zone in the regular spraying work the following season. There appeared to be some doubt, however, as to its efficiency and in the spring of 1940, in cooperation with the State Entomologist of Connecticut, plots were sprayed at Simsbury and Granby, Connecticut and some additional tests were made in September and October to improve the equipment. A description of the apparatus was published by A. F. Burgess and A. G. Galloway in the Journal of Economic Entomology in December 1940, volume 33, number 6, page 912. (Plate LXII)

In 1941 large woodland infestations in five towns in Connecticut, Vermont and Massachusetts covering a total of 593 acres were treated. These infestations were selected because they were in difficult areas where ground spraying was prohibitive. The following year an infestation covering a large area on Canaan Mountain, Connecticut of 1,260 acres was treated and the decision was reached to use the giro as regular equipment on gypsy moth woodland spraying.

There are certain limitations in using airplanes for spraying in rough woodland country that cannot be avoided. In addition to the periods when rain falls or fog is present during the spraying season the wind is a governing factor. This necessitates treatment being

made when the air is calm, just after daybreak and continuing until strong air currents make the work prohibitive. It is sometimes possible to do this work at other times of the day particularly late in the afternoon if the air is calm. The availability of landing fields from which operations may be undertaken is a most important factor since there is direct relation between the distance it is necessary to fly from the field to the infestation and the number of loads of insecticide which may be applied.

Transportation of Field Personnel

During the early years of the work to exterminate the gypsy moth by the Massachusetts Board of Agriculture the men employed as laborers and scouts were hired to work in the territory nearby their homes. The labor supply was plentiful during this period, the infestation was chiefly centered in the thickly populated section surrounding Boston and the workers were thus able to reach the job by walking or at the cost of one carfare. For this reason transportation was not a serious administrative problem. The supervisory force was not large and the area under supervision of any one man was so small that it could be covered easily by electric streetcar, railroad or by horse and wagon. Cost of such transportation was paid by the State Board of Agriculture as usual expenses - an instance of one arrangement for providing means of transportation was to allow a travelling supervisor a rate of $2.00 per day in addition to this regular per diem wages for use of a horse and vehicle for travelling.

Later when the Federal work began in 1906 and the roadside strip method of control was used the crews moved from town to town when necessary and transportation was not a serious problem as the work

was usually near their homes. Within two or three years, however, the strip work extended over longer distances and scouting crews were sent to the outlying towns for determination of the infestation limits which necessitated in some cases a considerable amount of travel. While so far as possible men were hired to work in their home towns this was practicable only for crews engaged in rough laboring work. Scouting was and is a specialized job requiring no little experience and it was most desirable that experienced men be employed even though they were to work at a distance from home. Scouts therefore were furnished transportation by railroad or electric car lines to and between the towns in which they scouted. While in the town being scouted they boarded usually at private homes and walked to and from the field each day.

The supervisors during the first three years used public means of transportation or hired local conveyances but the work was constantly getting farther from such means as infestations were discovered in more remote districts. As a result in 1909 motorcycles were purchased and furnished for use by the supervisors which was the first Federally owned transportation equipment on the gypsy moth work. (Plate LXIIIa)

It was obvious that motorcycles were very convenient, the supervisors were able to travel without regard to timetable schedules or the limitations of carriage hire and were enabled to cover their sections more frequently with great efficiency. Yet motorcycles were not all-weather and all-roads vehicles and small supplies so often needed in the field could not be carried on them. The infested territory by 1913 had extended over much of New England and supervisory trips covering long distances were made in rented automobiles at

considerable annual expense. It appeared that on the basis of economy and to save travel time the purchase of automobiles was warranted, at least for the use of supervisory officials. The idea of acquiring automibiles for field use was a decided innovation and when it was proposed there was at first considerable hesitation in setting such a precedent.

Nevertheless, the obvious economy was so evident that the purchase of one Ford and one Chalmers, both touring cars, was authorized in the late spring of 1913. (Plates LXIII and LXIIIa) It is believed that these were the first automobiles purchased and used by the Federal Government outside of Washington in the Department of Agriculture.

The proposal was advanced that further economy and efficiency could be obtained if bicycles were furnished to men working along the western border of the infested territory particularly during the season of applying and tending tangle-foot bands. This idea met with instant approval and 30 bicycles were purchased so that for the first time men of the scouting force on special work were individually supplied with transportation equipment. Later in the year 55 more bicycles were purchased.

The advantage automobiles had over motorcycles was so convincing that in 1914 the section supervisors were furnished with Ford automobiles which enabled them to travel greater distances over their large territories during most of the year. At this time even main roads were not generally plowed and heavy snow of course prevented automobile travel, particularly on country roads, yet most of the infested region could be reached at least between the larger towns and cities on the hard roads, even under the most adverse weather conditions.

It was not long before the ever increasing number of motor vehicles and the spirit of adventure to explore the countryside by motor resulted in great extension of good hard surfaced roads into the rural districts. It was only to be expected that the gypsy moth work did not remain outmoded and its transportation facilities kept pace and grew with the progressive trend.

The war with Germany in 1917-1918 gave added impetus to the development of better motor equipment and highway construction. Shipment of merchandise over short distances by motor truck proved to be more economical than by railroad and business men found they could reach their markets more frequently and with greater ease by automobile. America had entered the Motor Age.

Experience had shown the methods employed in scouting for the gypsy moth were probably well developed although technical improvements were constantly attempted. The crews were moved from town to town by car or truck and were able to find boarding houses within walking distance of the woodlands each day. Quarantine inspectors were assigned automobiles during the war period and this resulted in quicker service to the shippers.

When the depression began in 1930 it caused at first a severe curtailment in the field work. In 1933, however, large relief appropriations became available primarily for the purpose of relieving the tremendous unemployment problem which threatened an economic catastrophe. Under the National Recovery Act limitations were imposed so that the appropriations were allotted almost entirely for wages. It was possible to assign the workers so that the boarding house system away from home could be continued but the available motor equipment

was inadequate to move the increased supervisory force and to transfer men. This was alleviated somewhat by the transfer of a large fleet of trucks which had been used on the Federal Corn Borer campaign of 1927-1928. These trucks made it possible to meet the transportation problem during the NRA program.

In 1935 the Federally sponsored Works Progress Administration gypsy moth and brown-tail moth projects were initiated. The program called for the assignment of needy persons from relief rolls to work within the towns or county limits of their place of residence. These workers were almost entirely heads of families, the wage rates did not allow sufficient funds to maintain the home and for board elsewhere, so that it was imperative that they should not work long distances from home requiring outside board. In fact the WPA national program aimed at maintaining the home through the depression period. Many of the workers at first and even more later could not do a hard day's work if it had been necessary to walk several miles to and from the job each day. The funds were allocated so that the major portion was spent directly for wages but there was provision for purchase of necessary supplies including transportation equipment. This made it possible to procure necessary replacements and purchase new equipment essential to operate the increased volume of work. This arrangement was more economical and satisfactory than to hire transportation on a rental basis. At the employment peak of the WPA work in 1936-1937 about 7,400 men were assigned to the projects and a total of 271 pick-up body one half ton trucks and 96 platform body trucks were used to transport crews and supervisors in addition to several sedan type cars purchased with funds from the regular appropriation for official use or special assignments. (Plates LXIV and LXV)

Office, Shop and Storage Facilities

When new facilities were sought in 1931 for housing the headquarters of the gypsy moth control Division the first consideration was to find a city located most advantageously for administration of the work which at that time was largely confined to the barrier zone. It was desirable also to secure sufficient space for possible expansion as well as immediate needs. Selection of the present location in Greenfield, Massachusetts was the result of these considerations. This town is situated on intersecting main State highways and main line railroads over which all points within the infested area are reasonably accessible. The buildings available for use consisted of several substantial fireproof units, all within short distances of each other, which have been adapted to the peculiar needs of this Division. (Plates LXVI and LXVIa)

Plate LXVII is a floor plan of the office building, a two story concrete structure originally designed for use as a cafeteria for the employees of the Greenfield Tap and Die Corporation, from whom the buildings were leased. The second floor was most suitable for housing the administrative and clerical force since it allowed for more privacy and for convenient arrangement of the administrative sections most desirable for efficient office management. Space on the lower floor was arranged to the best advantage for use in storing files, operation of office mechanical equipment, and for occupancy by other office activities.

The building selected for a repair shop is a large ell shaped one story structure, heavily built, and formerly used to house heavy machinery. Considerable care and thought has been given to utilizing the

available space in the most efficient manner. Plate LXVIIa gives the floor plan layout which has proven to be satisfactory for efficient operation. Repair machinery and tools are conveniently situated for handling all types of project repair work in an orderly manner. Work with and storage of inflammable materials have been isolated in rooms or sections of the building to eliminate fire hazards.

One building (Plate LXVIII) is used almost exclusively for storage of equipment including spray machinery which is used only part of the year and heavy machines and trucks which need not be moved about frequently. A second storage building (Plate LXVIIIa) has been arranged for storage of spray hose, arsenate of lead and other equipment. The hose is placed in bins stretched lengthwise and kept in the best way to preserve its life and prevent undue deterioration. The arsenate of lead is stored on racks above the floor where there is less chance of moisture damage at a height allowing space beneath for car or small truck storage. Space is provided also for benches and tools for repair of the hose and hose couplings.

Small buildings grouped about or attached to the main storage and repair shop units as noted on the plans have been fitted or temporarily erected for use in storing miscellaneous tools, small equipment, etc., some of which is used only during part of each year.

The arrangement of the available space in all these buildings has been the result of careful planning and experience in the particular needs of this Division. During the period from 1931 to the present, Division activities have varied from a routine pace to extraordinary demands upon storage, repair and office facilities when emergency projects were operated. The space arrangements described have been most efficient under these differing conditions and may be recommended

PART XV

Defoliation and Damage Caused by the Gypsy Moth

The gypsy moth defoliaties trees which results in partial or complete elimination of foliage in late June and early July. This interferes with the formation and normal development of new wood. Deciduous trees in the northeastern United States normally produce one crop of leaves annually but defoliation forces the production of a second crop of foliage in July or in August. This is an additional drain on the vitality of the trees and adversely affects their normal growth.

In the case of shade, ornamental and roadside trees disfigurement of the foliage or its partial or complete elimination in midsummer is highly objectionable and together with the stunting or death which follows partially or permanently reduces or wipes out their value. Heavy expenditures are necessary to destroy this pest if these trees are to be preserved in a healthy and vigorous condition.

The money value of most New England forests on an acreage basis is so low compared with the value of shade and ornamental trees that unless the trees are approaching the age of commercial lumber when protection may be justified, it is impracticable to make large expenditures for treatment or protection in badly infested woodland areas as this would not yield a profit based on lumber value only. Conifers, particularly the white pine which is well adapted for growth in most of the New England territory, are of the highest value commercially and succumb most quickly to the attacks of this insect if grown in mixed stands and small natural seedlings are killed easily when grown as an understory at a time when their potential value for restocking the area is very great. If grown in solid stands the white pine is

practically immune from attack.

In the early days of the gypsy moth work large areas of most valuable white pine were cut because of the ready market and the danger of killing due to this destructive pest. Unfortunately the natural reproduction which followed has been chiefly deciduous species which are more susceptible to attack by this pest, and it has resulted in a marked increase in woodland acreage which is of far less value and most difficult to protect. Evidence of killing of trees and widespread damage increased rapidly after 1900 and with the resumption of State work in Massachusetts in 1905 followed by Federal work the next year systematic cutting and thinning operations and treatment measures for tree protection were resumed.

Reference has been made earlier in this report to the plan that was adopted in 1911 for gathering detailed notes on the behavior of the insect in 250 selected plots scattered over the infested area, and that individual tree by tree records were taken in these plots each year over a ten year period. Before the end of the period many of the plots were eliminated for various reasons so that by 1921 the number had been reduced to 185. During the early part of the period extensive laboratory experiments were conducted relative to the preference of food plants attacked by the different larval stages of the insect. This phase of the work was finished first and the results were published in 1915 by Mr. F. H. Mosher as United States Department of Agriculture Bulletin No. 250, to which reference has also been made.

After the completion of this study the work of compiling and tabulating the large mass of data secured was undertaken, most of which was assigned to Mr. C. W. Minott and Mr. I. T. Guild, During this work a special study was made to determine the loss in wood production of var-

ious species of trees due to retardation of growth based on defoliation. This work was very carefully done and all doubtful cases were eliminated. The results were published, after approval by Dr. L. O. Howard, Chief of the Bureau of Entomology, in the Journal of Economic Entomology in 1925 and revealed that the loss in annual growth was directly proportional to the rate of defoliation of the trees concerned.

The work of assembling other data on the observation points continued and information was gradually compiled on the loss due to the killing of trees by the gypsy moth. In 1932 Dr. Strong, Chief of the Bureau of Plant Quarantine, requested that this information be forwarded to him but owing to the death of Mr. Minott and the retirement of Mr. Guild, Dr. John N. Summers prepared the data from the work sheets which were available. The selection of Dr. Summers for this task was governed largely by his excellent training and well known conservatism in evaluating data. The report was prepared and submitted to Dr. Strong who expressed his satisfaction with its usefulness as a guide to the damage caused by the gypsy moth and submitted the following abstract of the conclusions to the subcommittee of House Committee on Agricultural Department Appropriations for 1934 to indicate the importance of this pest:

"The damage caused by gypsy moth may be classified under six types:

1. Damage which results in the death of forest trees.
2. Damage which results in retardation of the growth of forest trees.
3. Damage to forest stands as a whole, a promiscuous killing of trees which results in imperfect growth of the remaining trees.

4. Injurious effect on forest and water conservation, due to the denudation of forest trees, over large areas in mid-summer.

5. Decrease in sale or rental value of residential property, camps, etc., due to presence of hosts of caterpillars.

6. Damage to shade trees, street trees, and ornamentals.

"Definite information on the first two types of damage is available through careful study over a period of ten years or more. Data on the amount of losses caused by the last four are not so evident and while real cannot be so readily evaluated.

"A study of the first two types was begun in 1911 and extends over the decade from 1912 to 1921, inclusive. In this study detailed records were kept of the percentage of defoliation and death of the trees from defoliation by the gypsy moth on 185 definite areas located in the forests of a portion of the infested region lying in southern Maine, southeastern New Hampshire and eastern Massachusetts, and were representative of approximately 1,179,758 acres of forest. These plots were 100 feet in diameter and the whole 185 comprised 33,356 acres, totaling 14,308 trees. They average approximately 429 trees per acre, 6 inches in diameter. In the ten years these plots were under observation, 4,741 trees were killed by the gypsy moth or about one-third of the stand. Applying these figures to the 1,179,758 acres of forest located in this area gives a total of 167,703,115 trees averaging 6 inches in diameter killed during 10 years. The loss of all these killed trees which included much high grade lumber, estimated on the basis of cord-wood 1/ on the stump at $2 a cord, which is the lowest valued forest product in NewEngland, totals $16,770,311.50.

"It has been shown by careful investigation over a long period that increase in rate of growth in trees is retarded by partial defoliation and that the retardation is directly proportional to the percentage of defoliation. 2/ This principle was established by determining the percentage of defoliation over a period of years on trees and then measuring the growth rings for the corresponding period in these same trees. In other words, if a tree has lost 25 per cent of its foliage, the amount of growth for that season will be 25 per cent less than would have been the case if it has retained its normal foliage.

"Careful tabulation of percentage of defoliation for the 10-year period shows an average yearly defoliation of 22.7 per cent which would result in a reduction of 22.7 per cent in growth. It has been shown by careful investigation that thrifty full stocked stands of timber will grow at the rate of 250 or more board feet per acre per year and the value of standing timber for lumber is from $5 to $8 per 1,000 board feet. The value of this increase in size of the trees under normal conditions would then be from $1.25 to $2 per acre per year. 3/

"Assuming the lower value of $1.25 per acre and calculating the reduction in stand due to death from defoliation, which is about one-third, 22.7 per cent decrease in growth would result in a loss of 19 cents per acre per year. For the 10 years during which these observations were made this would amount to a loss of $2,241,540 in the 1,179,758 acres of forest in which the 185 observation plots were located.

1/ Farmers Bulletin 715, page 18, table 8, states that 20 trees 6 inches in diameter yield 1 cord of wood.

2/ The principle published by Minott and Guild, Journal of Economic

Entomology, volume 19, 1925, page 345.

3/ These figures quoted from Farmers Bulletin 711 (1916).

"Data on the percentage of defoliation in the infested area outside the portion included in the region in which the 185 observation plots were located were obtained. Calculating the damage on the 2,076,277 acres of woodland in this area for the periods in which heavy defoliation from the gypsy moth occurred - these periods were not in all cases for the full 10years - gives a further loss of $2,534,737 due to decreased growth, and an estimated loss of at least $10,000,000 due to trees killed in this area. The total losses in the infested area during the decade may be tabulated as follows:

"Loss to forests by death of trees and decrease in growth because of defoliation by gypsy moth in decade 1912-1921, inclusive

"In observation plot area, approximately, 1,179,758 acres:

Loss due to death to trees	$16,770,311.50
Loss due to decrease in growth	2,241,540.00
Total	$19,011,851.50

"In infested area adjoining observation plot area, approximately 2,067,277 acres:

Loss due to death of trees estimated	$10,000,000	
Loss due to decrease in growth	2,534,737	12,534,737.00
Total		$31,546,588.50

"Using the data obtained on the area in which the 185 observation plots were located and upon which reasonably exact data are available it is evident that the losses on 1,179,758 acres of forest in 10 years are $19,011,851.50 or $1.61 loss per year, considering the losses due to

killing as fuel wood at $2 a cord on the stump and decrease in growth as lumber at $5 per 1,000 board feet on the stump.

"From these data, it would seem that a heavy infestation of gypsy moth in forests of any of our northern States would be liable to cause a loss of approximately $1,61 per acre per annum.

"The effect of the other four types of losses can not be so definitely evaluated. It is of interest that States, Municipalities, corporations, and individuals spent more than $950,000 in 1931 for the protection of shade and ornamental trees in streets, parks, playgrounds, and private estates. This represents the cost of effective protection in a comparatively limited area. No record is available as to the cost of protecting fruit trees from this pest."

Prior to 1934 the records of the severity of infestation were determined chiefly on the density of egg deposit secured from various officials and others familiar with the infested area and on this information was based the probably areas of defoliation for the following summer. This proved very unreliable due to mortality of eggs by extreme cold or death of larvae at hatching time on account of unfavorable weather conditions and a plan was put in operation to record actual defoliation by specially trained men during the summer. Each year during the season of gypsy moth caterpillar feeding and as near the date of maximum feeding as possible, experienced employees and collaborators of this Division were assigned to definite sections to observe the amount and degree of defoliation throughout the entire gypsy moth infested territory. These men travelled by automobile, covering practically all roads in each section, having been furnished with road maps for the purpose, and based their estimates on the percentage and extent

of defoliated areas visible. Records were at first imperfect but after experience and improvement of the system it was possible for the man to closely gauge the areas defoliated within 25, 50, 70 and 100 per cent classifications. There was considerable difficulty in many areas in determining that all the territory had been examined since the blanketing effect of a small amount of foliage or uninfested ridges obscures a full view of partially or wholly defoliated sections. Also, estimates without close examination of the defoliation of pine are particularly difficult since at a distance partial defoliation is difficult to determine. These factors tend to present an underestimation. As a guide to indicate some definite standards, trees were artificially defoliated to different percentages as shown by Plates LXX and LXXI. Such illustrations helped in securing a more accurate estimate.

Four weeks or less was the limit of time that could be used to cover the entire territory before refoliation made the gathering of data impossible. Without the cooperation and assistance extended by officials in each State this work would have been impossible.

The data in the following table, which includes the years 1924 to 1942, is a total each year of defoliation ranging from 25 to 100 per cent. During the last year of this period it was impossible to carry through the survey with the same degree of thoroughness as in previous years on account of the necessity of detailing the small Federal force available to other work.

Acreage Defoliated by the Gypsy Moth
1924-1942

Year	Acres defoliated	Year	Acres defoliated	Year	Acres defoliated
1924	825	1931	204,720	1937	608,760
1925	48,615	1932	286,395	1938	313,954
1926	80,822	1933	397,730	1939	492,640
1927	140,920	1934	492,361	1940	485,636
1928	262,514	1935	540,769	1941	467,517
1929	551,133	1936	428,622	1942	44,577
1930	388,525				

These figures are inadequate since they cannot give the reader, who may be unfamiliar with the conditions, a real picture of what has happened. In some areas of heavy infestation caterpillars will strip the trees so thoroughly over large acreages that they will be as bare of foliage as in winter. There have been many instances where partial to complete stripping has been observed covering thousands of acres and from a distance these huge seared patches of defoliation as far as the eye can reach appear to be the result of forest fires. (Plate LXXII) It is not uncommon to observe equally large acreages, where feeding is lighter and stripping is not complete, where the trees appear to be not fully leaved out or to be dying, in sharp constrast to neighboring parts of the woodland which have escaped defoliation. In the years following, these places where defoliation has occurred are marked by the presence of dead trees standing out clearly among others in the forest which have survived only because they were more vigorous or less favored as food. (Plate LXXIIa)

The bulk of the tabulated defoliation was in Maine, New Hampshire and Massachusetts, although 17,750 acres were recorded in Rhode Island in 1934 with lesser amounts in years before and following this peak. The greatest amount of defoliation occurred in Vermont in 1939 when 5,311 acres were reported, with over 3,000 acres the following year. For the rest of the period the amount ranged from only a few hundred acres to no defoliation at all. In Connecticut 4,224 acres were recorded in 1939, an increase from 1,339 acres in 1938. In other years the defoliation was much less and in nine years of the period none was recorded in that State. The heaviest defoliation occurred in towns between the Connecticut River and the barrier zone.

No defoliation has been recorded in the barrier zone during the entire period with the exception of a few colonies which were thoroughly treated at the time they were found. The same conditions occurred at a few colony sites outside the zone area in New York, New Jersey and Pennsylvania and defoliation was rarely noticeable in any areas the years following the application of thorough treatment.

In Massachusetts west of the Connecticut River and in Vermont defoliation has been found chiefly in the territory reasonably near the river, the amounts sharply decreasing toward the eastern border of the barrier zone. This has emphasized the necessity for intensive work between the zone and the Connecticut River as the danger of windspread of the small larvae increases greatly when the caterpillar population is built up to a point of defoliating the trees. The dearth of defoliation in Connecticut, and to a less extent in Rhode Island, resulted from treatment which had been applied in these States and from the fact that during some years weather conditions were favorable for the drift of small larvae to the territory northward. Similar work in New York, New Jersey and Pennsylvania prevented increase of the caterpillar population and consequent spread of infestation. The abundance of the insect and the degree of defoliation is adversely affected by unfavorable weather for its development, reduction in numbers by parasites and natural enemies, and by the amount of treatment work that can be applied.

No records have been made of the annual defoliation of shade trees on the streets or private property in cities and towns, or on the roadsides in rural areas. This occurs frequently in the generally infested area. Aside from the damage caused such trees furnish dangerous sources for windspread of the newly hatched larvae, as they usually grow in the

open where there is greater opportunity than in the forests for the small larvae to be distributed by the wind. Doubtless many local infestations have been started because effective treatment has not been applied to control the gypsy moth and properly protect this great national asset.

The prevention of damage to trees in parks,on streets, residential properties and on rural roadsides has necessitated heavy expenditures for treatment by cities, towns and private owners and this is likely to continue. It is exceedingly difficult to estimate accurately the value in dollars of shade trees but parks and public reservations would be practically worthless without them. In an article titled "Importance of Shade Trees to the United States" before the 5th National Shade Tree Conference and published in their proceedings for February 1929 Dr. E. P. Felt estimated that there are approximately 5,000,000 shade trees in the United States with an average value of $10.00 per tree. Their worth may be evidenced, also, by the willingness of the public to make heavy expenditures for their protection and preservation. A country without them has lost a most valuable asset.

Defoliation takes place in midsummer when the weather is hot and destruction of the forest canopy at this time rapidly increases the rate of moisture evaporation from the soil. Many small streams dry up, tree growth suffers on account of moisture deficiency, the ability of trees to recover and produce a second crop of foliage is reduced, and in forested watersheds the normal run-off to reservoirs is adversely affected. In some cases the loss of foliage contributed to erosion resulting in depletion and eventual loss of fertile soil. It also makes such areas more susceptible to forest fires.

Losses due to gypsy moth damage to growing crops have been reported many times, usually without detailed date of monetary losses which have always been difficult to calculate. Reference has been made to damage to the cranberry crop on Cape Cod and the best methods for controlling the insect on cranberry bogs. In spite of the fact that all or some of these methods are used losses have continued to occur. In 1933 a careful check was made to determine the actual reduction in the crop as a result of gypsy moth feeding and it was found to total 16,888 barrels having an average market value of $9.00 per barrel, which was a loss to the growers of $151,992. This is not a yearly loss but is typical of losses which have been sustained in several seasons of gypsy moth abundance. These figures cover loss of crop only and do not include injury to the plants themselves.

Calculations of woodland losses due to gypsy moth damage have not been made in recent years as the necessarily detailed observations have not been possible, but the defoliation records made beginning in 1924 clearly indicate a great increase in the amount of defoliation over larger areas, much of which had not been previously exposed to this damage. For this reason accurate information of the damage which has occurred is not available either in the older infested area or in the territory since infested. Records indicate an increasing acreage of defoliated areas over the territory as a whole and there is no doubt that the retardation of growth and the killing of trees, many of which were of merchantable size and were of greater intrinsic value than the average of the trees previously reported, has occurred widely over the entire territory. It is reasonable to assume that the damage caused by the insect since 1921 due to death and retardation of growth is

equivalent to that based on the observation points. Experienced observers have noted that it has continued to be widespread and there are many instances where thousands of trees are dead or in a dying condition as a result of defoliation in recent years. A few typical cases follow.

An area consisting of oak and pine extending over 200 acres in Sandwich, Massachusetts, on Cape Cod, was noted in 1926 to have been completely defoliated resulting in the death of the pines and serious damage to the oaks. This is only one example of repeated defoliations and resultant death of trees in that part of the State. (Plates LXXIII and LXXIIIa) In 1935 a forest consisting chiefly of black oak intermixed with some red and white oak was almost 100 per cent killed at Groton, Connecticut near the shore of Long Island Sound. (Plates LXXIV and LXXIVa) There has been repeated defoliation throughout southern New Hampshire extending as far north as Conway and in the Lake Winnepesaukee region heavy stripping followed by killing of trees was noted in 1939 and 1940. (Plates LXXV) A State of Maine employee with many years of gypsy moth experience reported heavy feeding and defoliation in the vicinity of Sebago Lake. These observations were confirmed by officials of the Greenfield office and it was found that in 1941 killing of trees extended over 4,400 acres in that region alone. (Plate LXXVa) There have been numerous examples where identical conditions have existed within the last five to ten years, many of them not many miles east of the barrier zone, such as in Windham and Rockingham, Vermont, (Plate LXXVI) in the Granby-Simsbury section of Connecticut, (Plate LXXVIa) in Harpshire and Franklin Counties in Massachusetts, and many instances of isolated trees or groups of trees throughout the en-

tire generally infested territory that have died. Defoliation and killing have not been confined entirely to the favored food trees; even in recent years evidence has been noted of less favored trees that have been killed, retarded in growth or permanently damaged. (Plates LXXVII, LXXVIIa, LXXVIII, LXXVIIIa, LXXIX, LXXIXa, LXXX and LXXXa) In 1940 a row of large American elms were completely defoliated at Henniker, New Hampshire and only partly refoliated later in the summer.

The possibility of further spread to the west, increasing defoliation and damage, cannot be discounted on the basis of lower relative favorability of available food plants. A survey of shade trees was made in July 1936 by two experienced observers of this Division on one of the main trunk line State roads extending from the New York State line to Orleans on Cape Cod in Massachusetts, a distance of 260 miles, 212 of which were through rural country. It was found that on the average 38 per cent of the trees were favored food, 27 per cent were conifers and beech, 27 per cent intermediate and only 8 per cent non-favored. The sprout growth and brush along the roadside were 46 per cent favored food, 20 per cent conifers and beech, 28 per cent intermediate and only 6 per cent non-favored. These classifications were based generally on those established by Mosher in Bulletin No. 250. It was observed that in many scattered towns favored food exceeded 50 per cent in all sections of the State from Hancock on the New York State line to Bourne on the Cape Cod Canal. This roadside survey was not intended to show the proportion of favored food trees over the whole infested area but it seems reasonable to assume, in view of the fact that so much of the surveyed area was in rural territory, that it may be a fair sample of the types of tree growth, and that much favored food is

present and should be protected west of the more heavily infested area in order to prevent spread of the insect to the uninfested areas further to the west.

It seems clear, also, that the alarming damage reported in the early years of the gypsy moth work has not been eliminated as a dangerous possibility for the present or immediate future. Records do not indicate any fixed or general periodicity of abundance of the insect because of many varying factors, Heavy defoliation and resultant damage follow seasons favorable for increase of the gypsy moth unless treatment work is promptly and efficiently applied. No particular section or area of New England excepting perhaps certain localized parts of northern New England may be safely considered immune from damaging attack. It is true that in some localities in southern New England the increase of the insect has never developed normally - whether this is due to little understood ecological, climatic, or other natural factors is an unanswered question except in very generalized theory.

The possibility of spread of the insect beyond its present range in the United States and the probability of damage comparable to that experienced in eastern New England, if such spread should occur, is an ever present source of speculation. The value of the barrier zone program has been discussed, with an indication that efforts for its maintenance should be continued, which is a policy with which the most vitally interested authorities have agreed. The basis for this policy is, first, the fact that the natural range of the gypsy moth in its native lands extends over an area embracing the varying climatic conditions

which are also found throughout the entire eastern half of the United States and consequently do not seem to preclude the possibility that the insect can survive anywhere in this territory. Second, according to publications of the United States Forest Service, thier is an abundance of the most favored food, considering only the several species of oaks which are listed as the most important or abundant of forest trees in the Central Hardwoods Forest and in the Appalachian Region of the Northern Forest. Oaks are considered as second in importance or abundance in the Southern Forest pine lands and rank high in the northern portion of the Northern Forest. Korstian and Ruggles, in their report of February 3, 1941, noted that the value of this timber only, in New York, New Jersey, Pennsylvania, the Central Hardwoods Region and the Appalachian Region, approximated five hundred million dollars. Even assuming that the gypsy moth should never reach the damaging abundance of eastern New England it seems evident that enormous losses could occur and almost certainly in some areas a combination of favorable factors would be present where defoliation and tree killing would equal or even exceed that found in the present generally infested area. When consideration is given to the fact that forest trees of less abundance but equally susceptible to attack and trees of purely aesthetic value would also be liable to damage the possibility of probable loss may well be staggering. What reaction there might be for control of the insect in the forests is problematical but unless the forest acreage value is high intensive control measures over large areas would perhaps be considered uneconomical. Undoubtedly in parts of the territory where shade trees on streets and private estates have high value expenditures for their protection would at least equal those in New

England and the ultimate cost due to the larger territory would be many times greater in this respect alone.

In addition to the expenditures for control and prevention of damage, the cost of enforcement of quarantine regulations throughout the newly infested area would be multiplied over the amount presently required in proportion to the increase in infested territory. This would be of significance to nursery interests who would be subject to the inspection requirements of the quarantine, and since there are many large nurseries located outside of New England in the eastern part of the United States costs for compliance with the regulations and for maintenance of the inspection service would amount to a large annual expense.

Experience would seem to prove that the only proper course to prevent spread and damaging defoliation by the gypsy moth lies in the path of continued intensive methods varied according to the problem encountered for its control and eradication wherever and whenever possible.

PART XVI

Cooperation

Successful cooperation must be based on the willingness of organizations to come to common agreement on procedures to effect a common purpose and this cannot be successfully accomplished without the existence of full confidence by the parties concerned.

It is easy for Federal activities to overlook the fact that States or private individuals have rights and that they usually take personal pride in the properties which they own or control and in the methods which they may use in doing work on their own properties. This condition cannot be ignored if maximum results are to be secured by cooperative effort. The Federal gypsy moth project has been successful during many years in operating in many States where conditions varied widely and local laws or ideas and sometimes prejudices made it difficult to produce effective results, but it has been fortunate in being able throughout the long period when work was carried on to effect satisfactory mutual understandings with States and other agencies as well as individuals so that a minimum amount of friction has resulted. It has always been possible to meet and discuss matters which were essential to the work and by explaining the need arrange for changes to improve the work.

In the case of individuals with whom our field men come in contact it has seldom been necessary to make changes in the plan for operating on any particular property due to their tact and understanding of the problem coupled with a full explanation of the reasons for doing the work proposed. During the years this has developed a feeling

of good will between this office and the States and other organizations with whom frequent contact was necessary and it is pleasing to acknowledge that as a result of this condition there have been many times when State officials have gone far beyond what might be reasonably expected to assist the Federal office so as to accomplish work which circumstances made it impossible for the latter to attempt. This has been a characteristic of all of the States concerned regardless of frequent changes in the personnel who were directing the State work. The Federal office has always endeavored to furnish the States with information and such assistance as was possible in carrying out their part of the work which has strengthened reciprocal relations.

A striking example of this confidence resulted in the request by the State of New Jersey to the Federal office to manage the exterminative work on the gypsy moth in that State and it financed with State funds practically fifty per cent of the expenditures which in the end aggregated approximately $2,000,000. Throughout the period that this work was carried on an excellent spirit of cooperation existed which greatly facilitated the operations and contributed to the outstanding accomplishment of exterminating the gypsy moth from that State. Funds which were needed were always promptly furnished and the work proceeded with a minimum of difficulties and with almost clocklike precision.

The same type of cooperation was furnished in Pennsylvania under trying conditions during the depression when this project was financed largely by relief agencies and personnel problems owing to heavy turnover of men severely taxed the administration of the work. The accomplishments were satisfactory in spite of the fact that much of the work had to be carried on in mountainous wooded country where the

difficulties of operating were unusually severe. These results have been largely due to the cordial cooperation of the State Bureau of Plant Industry and the Department of Forests and Waters. Several cities, notably Scrantón, furnished assistance by supplying tools and storage facilities when a sufficient supply was not available which materially benefited the work and the Scranton-Spring Brook Water Service Company supplied water for the use of sprayers which were operated in remote scattered areas without charge to the State or the Government and provided land for storage of materials and equipment at a nominal rental.

Both the State Department of Agriculture and the Department of Conservation in New York cooperated fully with the Federal office and the confidence which this office had in the latter Department, on account of the State work being operated by Mr. H. L. McIntyre who had long experience with the Federal organization, led the Bureau to place most of the barrier zone work in that State under the direct supervision of that Department.

After the barrier zone was established the State Entomologist of Connecticut concentrated a large part of the State work in the territory immediately east of the zone for the purpose of protecting it from infestation and assisted the Federal project by spraying and oher protective work.

In fact all of the States concerned during the period when emergency projects were operating furnished a large part of the supervision so that work on the brown-tail moth as well as the gypsy moth could be satisfactorily handled. Without this cooperation, in addition to the regular State programs which their forces had to operate, many of these emergency projects could not have functioned and this Division

would not have been able to furnish much needed work to unemployed during the depression period. No pressure was required to bring about this free will assistance and great credit is due to this fine attitude which had developed as a result of cordial relations which existed over many years. The emergency projects, some of which continued for a relatively short period, included the HRA, the CCC, and CWA, the WPA and the NYA.

Each operated under regulations designed to meet emergency conditions and of necessity many of the rules were diverse and complicated and were frequently modified to meet rapidly changing conditions. Frequent changes in the administrative personnel and policies rendered management of field operations more difficult than had been the case under the regular gypsy moth project. This necessitated careful planning of field work to prevent duplication and confusion.

All of these emergency projects were working under high pressure but sympathetic consideration of the needs of the gypsy moth and browntail moth projects was the rule and much useful work resulted.

The administrative office of the Bureau in Washington was a tower of strength in unravelling many complicated problems, the solution of which was vital to successful operation.

Cooperation has always existed with the various Division of the Bureau of Entomology, the Forest Service, the Department of the Interior, the United States Employment Service and other agencies so that the gypsy moth project had access to useful information to help on problems relating to this project. This good spirit of cooperation extended even beyond the area known to be infested and where the struggle was being made to limit the spread of the gypsy moth. Appreciation of the work was

was voiced by many States outside of this area and keen interest and great appreciation was frequently expressed that they were being protected from invasion by this pest. The same helpful and friendly relations have alway always existed with the office of the Entomologist of the Dominion of Canada.

Attention has been called previously in this report to a nation-wide conference which was held in Washington December 4, 1934 by Dr. Strong, Chief of the Bureau, when the project was in critical need of support and funds, to consider particularly the question of whether eradication of outside colonies and the maintenance of the barrier zone should be continued or abandoned. Officials from many States extending as far west as the Pacific Coast attended this conference and without exception urged that there be no relaxation in the work, while others who could not attend indicated their approval by correspondence. One activity expressed the idea that the insect was of minor importance but did not advocate the elimination of the work.

Many of the most eminent foreign entomologists from nearly every country in the world visited the laboratory and field operations and expressed high regard for the work that was being accomplished. Such expressions of good will and confidence could not do otherwise than give encouragement to the men connected with it. In fact there were few important entomologists or others who took the pains to see what was being done and the progress that was being made who offered adverse criticism or suggested better methods of preventing the spread of the insect either by the adoption of new methods or improvement in old ones. The almost unanimous opinion seemed to be that the project was gradually accomplishing the purpose for which it was set up and the effort was not only worth-while but was of substantial importance to the country as a whole.

PART XVII

Expenditures Made and Benefits Derived

The accompanying chart, Plate LXXXI, indicates the Federal expenditures for gypsy moth work by fiscal years from 1907 to 1942 from regular appropriations excluding funds transferred to the Division of Forest Insect Investigations beginning July 1928 and those for quarantine enforcement after January 1, 1934. It also covers Federal emergency expenditures on gypsy moth under NRA and WPA allotments and brown-tail moth under CWA and WPA allotments since 1934, together with State expenditures by calendar years from 1905 to 1942. The brown-tail moth projects were carried on under CWA and WPA funds for the purpose of furnishing work to unemployed and were supervised by this office and the State officials concerned. The gypsy moth expenditures under NRA and WPA were designed for the same purpose on the gypsy moth project, the regular Federal funds being used for supervision and for a part of the needed supplies and equipment.

It is interesting to note that the combined expenditures by the States concerned as reported by the officials in charge of that work averaged far greater than the regular Federal appropriations during the entire period and that during the time when emergency funds were provided for the relief of unemployment by the Federal Government and supervised by this office, these funds exceeded the funds expended by the States in only three of the nine years when they were available. The State expenditures of these amounts in the New England territory were made in areas east of the barrier zone. In New York both State and Federal funds were used principally in the section of the barrier

zone lying in that State and in other sections of the State where information was needed for the purpose of determining whether infestation existed and to clean up any colonies that were found. The work in the barrier zone in New York was supervised by the Conservation Department of the State of New York in cooperation with the Federal Bureau. In addition to this Federal work was carried on with the same objective in view when information was required relative to existing conditions in the zone or other areas to supplement the State work. In New Jersey and Pennsylvania by arrangements with the States the arrangement of the work was handled by the Bureau, the States financing in the case of New Jersey practically an equal proportion of the funds and in Pennsylvania a smaller proportion due to emergency allotments. (See Plates XL and LIIIa)

After emergency funds were allotted in the fiscal year 1934 most of the expenditures were made for labor and supplies in the barrier zone and adjacent territory and in Pennsylvania. Smaller allotments were used to determine conditions adjoining the quarantine line in Vermont, New Hampshire and Maine as a guide to possible realignment of this line, in Rhode Island to determine conditions in the southern part of the State and to apply treatment, and in New Jersey to survey areas of possible infestation.

Prior to 1928 the importation, breeding and colonization of parasites and natural enemies of both the gypsy moth and brown-tail moth was of especial benefit to the territory east of the barrier zone. Other experimental work resulted in constant improvement in field methods. Up to January 1, 1934 the quarantine work, which provided for safeguarding shipments of materials likely to carry the gypsy moth

to points within and outside the infested area, was also carried on, at which time it was transferred to the European Corn Borer-Japanese Beetle Control Project for operation. The work of importing, breeding and colonizing natural enemies, the investigations in many countries in Europe as well as some areas in northern Africa and in Japan, resulted in the establishment of a number of beneficial species which attacked not only the gypsy moth but the brown-tail moth and were of great value to the New England States, particularly in sections where heavy infestation existed. Some of these useful species on account of their ability to destroy other insects have become established in other States and in Canada. On the other hand quarantine enforcement restricted movement of infested material within the known infested area and prevented infested materials from establishing new infestations throughout the United States as well as in foreign countries.

Inasmuch as the regular appropriation for gypsy/moth and brown-tail moth work had for its main purpose the prevention of spread of these moths from the infested area to points outside, the combination of three activities, namely, establishment and maintenance of the barrier zone, the introduction and colonization of natural enemies, and safeguarding the spread of the insects by quarantine and inspection requirements has in fact assured protection to the uninfested States from the danger of spread and damage which would have resulted if these projects had not been in force, and, it is believed, has paid good dividends in the way of protection to the country at large. In addition to this the extermination of the insect in New Jersey, the elimination of damage and decrease of intensity and extent of infes-

ted territory by treatment in Pennsylvania and the prevention of spread by maintenance of effective State quarantines cooperatively administered have been accomplished. This does not include the complete extermination of many small incipient colonies outside the barrier zone. (Plate LIV)

There is no doubt if the emergency work on the brown-tail moth had been continued for a period of years that the insect would have been completely exterminated in the New England States as during the three years of emergency work substantial progress was made in reducing the intensity of infestation and a considerable number of towns were completely cleared of the insect.

Emergency projects are expensive based on cost. Unemployed labor with a minimum of training can be used to advantage on such tasks as cutting trees, burning brush, applying and tending burlap or tanglefoot bands or assisting in spraying operations. Men can be specially trained in scouting, which is important and far more difficult work, to determine the location of infestations but must be moved to remote areas when the exigencies of the work make it necessary. The more capable ones will improve in efficiency with added experience. The conditions of employment particularly under the WPA projects did not permit free movement of men to be employed except for short distances beyond the towns in which they lived and subsistence wages were so low during the depression period that they could seldom be away from home over night. The fact that emergency jobs were designed as a temporary stopgap caused the men to seek private employment and resulted in tremendous turn over in employees which made it continuously necessary to retain substitutes, all of which increased operating

costs and multiplied the difficulty of supervision.

It will be noted on the chart that during the fiscal year 1934 over $1,500,000 was spent on NRA allotments. In 1935 no emergency funds were available and it was necessary to discharge all NRA employees. In the fiscal year 1936 a larger, WPA allotment was allowed. This made it necessary to train a new force. After 1937 funds were decreased annually until 1942 and added difficulties were experienced in replacing men after 1938 on account of improvement in business conditions and return of many employees to their former jobs. Emergency employees can be used to advantage as previously stated on certain types of work and can be trained for more skilled work. In our experience, many capable men who liked this type of work, would willingly have remained if the pay rates had been sufficient and the prospect of reasonably continuous employment could have been offered, but no regular funds were available for this purpose.

High morale is very essential in securing an output of good quality and quantity of work and the maximum results cannot be acquired under many of the conditions and restrictions governing emergency agencies. The purpose of emergency projects to relieve unemployment in times of depression is practical and laudable and to a limited extent such employment can be satisfactorily used on a project of the gypsy moth type but based on output of work greater accomplishments are possible when standard wages are paid and men are carried under regular funds so that they have some assurance that by doing excellent work there is a possibility for continuous employment.

PART XVIII

Organization

Several types of organization have been tried over considerable periods since the gypsy moth work was begun in Massachusetts in 1890, and the experience with these types may be useful as a guide for handling extermination or control projects on insects and other pests from foreign sources which may become established in the United States.

Type 1. No legislation is required, the work being left to the individual to take the most effective measures to meet the situation. This method proved unsatisfactory as uniform work was found to be impossible.

Type 2. State law providing right of entry on property to inspect and exterminate the insect, the work being done at State expense. In Massachusetts the work was first detailed to a commission appointed by the Governor but later was delegated to the State Board of Agriculture with full authority to exterminate the insect. This plan failed at a time when the severity of the infestation had been relieved and when a few more years of intensive work would have accomplished the desired result. Criticism and opposition by citizens in the infested area and apathy among residents in the non-infested area throughout the State developed, although the cost in the State tax was relatively small. The failure of the Federal Government to supply funds in order to prevent the spread of the insect to other States was also a discouraging factor. The inclusion of the brown-tail moth work with the gypsy moth project, after the discovery of the former insect in the same territory, without an increase of funds also complicated the problem.

Type 3. The Massachusetts law giving authority to carry on this

work on State and private lands and requiring city and town authorities to do the work in their own municipalities subject to State supervision, the cost being paid by the city, town or owner of the property concerned and partial reimbursement being furnished by the State if the cost was excessive. Other States which became infested passed special laws similar to the Massachusetts law in some respects or amended plant pest legislation to provide authority for clean up operations.

Type 4. When Congress made the first appropriation for gypsy moth work to prevent the spread of the insect it was based on cooperation with the States concerned and arrangements were made with the infested States so as to prevent duplication and overlapping of the activities. These provided for cooperative work particularly with the State of Massachusetts on the work on parasites of the insect imported from foreign countries and gradually other experimental work in connection with problems bearing on the spread and control of the insect were carried on at a laboratory financed jointly by Federal and State funds. In general the State concerned itself with control operations as the idea of exterminating the insect was abandoned after the work was temporarily discontinued in 1900 and after the insect was permitted to spread for five years with only local restrictions.

Under the type of organization indicated in Type 3 the work was placed under the supervision of the State superintendent for the suppression of the gypsy moth and brown-tail moth appointed by the Governor. Later it was transferred to the office of the State forester and strenuous efforts were made by the latter extending over a period of 12 years to solve the gypsy moth problem in forests by the application of silvicultural methods. In December 1911 at his request the

work on parasites was turned over to the Bureau of Entomology as it seemed only right that the Federal Government should support and control this work on account of the benefits being shared by other States as well as by Massachusetts.

In 1913 the Federal work was reorganized and one of the underlying ideas was to make a well balanced project having in addition to an administrative force a section on scouting, quarantine, and two sections of experimental work: silviculture and laboratory and field investigations, the latter with particular reference to the importation of parasites and natural enemies together with such other lines of experimental work directly bearing on the gypsy moth problem as might be necessary from time to time. This resulted in the establishment of a well rounded organization which could handle all the ordinary problems of the project and specialists could be secured for special assignments when necessary. This made possible the transfer of Federal field men from one section to another to meet unforeseen emergencies so that prompt service could be given, time saved and travel reduced. This was advantageous as the men had frequent opportunity to gain additional experience on different phases of the work which was useful to themselves and to the organization.

The silvicultural work was planned by the United States Forest Service and a technically trained forester assigned to lay out silvicultural plots in order to secure technical data which would be useful to the work. This proved to be a long time experiment. After these plots were established and had been under observation for a number of years and after the resignation of Mr. George E. Clement who had charge of the project it seemed desirable to combine the necessary routine

work with the laboratory and field investigations and this was done. Close cooperation with the States concerned and frequent conferences were held to decide matters of policy or procedure which were vital to all concerned.

Up to 1928 the results of the work of the entire Division were very satisfactory. By having headquarters for the heads of the sections at the central field office it was possible by frequent conference and discussion to develop worth-while lines of investigations which resulted in speedily improving the operation of the project. The discussion of observations made in the field brought out suggestions which were of great benefit to the project which could not have been secured in any other way.

As has previously been stated the laboratory work was transferred to the Division of Forest Insect Investigations of the Bureau in 1928 and the quarantine work to the Corn Borer Division in 1934. The removal of these sections which resulted in distributing the work among three independent Divisions made impossible those frequent contacts which were so valuable to the work as the latter were less frequent and more time consuming and caused the service to the public to be less satisfactory. In the opinion of the writer this rearrangement was a mistake and the organization of the work on the former basis would not only be in the interest of economy but would greatly increase the efficiency of the Federal gypsy moth work.

Summary

A summation with definite conclusions concerning the benefits of the tremendous efforts made to bring under control the gypsy moth and brown-tail moth is difficult even though consideration is given only to accomplishments achieved up to the immediate present. The effort is by no means completed and what its value may be in the future cannot now be accurately determined. Too many factors are involved, any one of which might have unpredictable influence upon the abundance and consequent damage of either insect, particularly if they should become established under new environments.

The pioneers in this work, who are referred to in the first part of this report, had abiding faith in the necessity and practicability of exterminating the gypsy moth. They were backed up by the most expert opinion of the time and had the courage to carry on the undertaking in the face of adverse criticism and insufficient funds. They did so well, in fact, that when success was almost within grasp apathy on the part of some citizens and opposition on the part of others, together with the failure of the Federal government to furnish aid to the project, brought about discontinuance of the work.

Reasons for the opposition are hard to define but in the light of values then placed on both shade trees and forests the apathy may be well understood. The desirability of tree protection was appreciated only by a minority since the supply of well stocked woodlands and sturdy shade trees appeared to be inexhaustible, and conservation for the future was an apparently unnecessary consideration. Such pests as the gypsy moth and the brown-tail moth were thought by many to be merely nuisances except in isolated instances and then chiefly

to only a limited number of property owners in restricted localities. Realization of the importance of insect pests and the enormous damage which they are capable of inflicting was not generally appreciated by the public until the early part of the present century.

The period from 1900 to 1905 soon provided a tragic illustration of the ability of the gypsy moth to cause havoc when suppressive efforts were left to individual, unorganized measures and enthusiastic public support soon materialized. Legislation was passed in 1905 in Massachusetts providing for State supervision of the work with reimbursement to cities and towns for sums expended in excess of legal requirements when unusual conditions of infestation demanded unusual expenditures. In 1906 the Federal government entered into the problem, since it had then become interstate in scope, and acted closely and cooperatively with the Massachusetts organization in parasite investigations in addition to scouting and treatment work throughout the infested territory.

Federal cooperation was extended to other States when necessary and in 1911 when the parasite laboratory was placed under Federal management an increasing amount of this type of work was done throughout the entire infested area.

The necessity for and value of quarantine activities to prevent widespread distribution of infested plant products and resultant spread of the pests was recognized at an early date. The authority to cope with this situation was given by the enactment of the Federal Plant Quarantine Act of 1912 which set up and empowered the Federal Horticultural Board to regulate and restrict movement of plants and plant products by means of a system of inspection and certification.

The quarantine on account of the gypsy moth and the brown-tail moth was among the first promulgated under the act and its effectiveness is evidenced by the remarkably small number of infestations that have been found beyond the quarantined or barrier zone area.

The Federal gypsy moth work was reorganized in 1913 and all Federal activities were centralized with Division status in the Bureau. This arrangement continued until the research work was transferred in 1928 to the Division of Forest Insect Investigations and the quarantine work was transferred in 1934 to the Japanese Beetle-European Corn Borer Control Division. The field control and extermination work was restricted to efforts for prevention of spread in the territory at the perimeter of the infested area and to the eradication of all outside isolated infestations which were discovered from time to time.

Although many serious and threatening infestations were eradicated throughout the years it was not until the gypsy moth was discovered in New Jersey in 1920 that existing methods were subjected to the supreme test. As the result of their application the insect was exterminated from that State. The successful conclusion of the project in New Jersey amply justified the faith of those pioneers in the convictions to which they so tenaciously clung.

The spread of infestation and lack of sufficient funds for an extensive eradication program led to the establishment of the barrier zone in 1923 where work was concentrated as a means for preventing spread of the gypsy moth into the States to the west and the south. Maintenance of the zone, in spite of the necessity for diverting part of the appropriated funds to the New Jersey and the Pennsylvania projects, has received the enthusiastic support of practically every

official and expert who were interested in its effectiveness or who have closely observed the progress of the work.

The infestation in Pennsylvania has received the most thorough treatment possible under emergency conditions existing during the past ten years by using substantially the same plan and objective so successfully applied in New Jersey. The measures taken are proving to be effective and both the area infested and the amount of infestation have been materially decreased as evidenced by lack of defoliation since the work started. Final success depends almost entirely upon sufficient funds and trained personnel being available for continuation of the methods used on a scale commensurate with the existing situation.

The fact that for eighteen years the spread of the gypsy moth beyond the barrier zone was restrained and that the outside infestations, with the exception of the area in Pennsylvania, have been promptly eradicated indicates that the methods employed have been sound. It is also significant that these methods, with many refinements and improvements developed in the course of the work, are largely based on those employed on the State work in Massachusetts prior to the turn of the century. There is unquestionably much credit due those whose ingenuity and clear thinking devised and perfected the quarantine and inspection service, the high pressure spraying methods and equipment, and the parasite introduction and liberation technique. These activities, among others, were brought to their present day standards by men engaged on the gypsy moth work and many other workers in the wide field of economic entomology are their debtors. It may well be said that the success of this program, secured as the re-

sult of effective cooperation of all the States and other agencies concerned, has been a source of inspiration for many workers in this field today.